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CONTENTS

AERONAUTICAL AND SPACE

Some Problems of Maintaining Temperature Conditions in Operation of Flightcraft and Other Complex Systems.....	1
Self-Contained Cascade Vortex Systems for Cooling Flightcraft Components.....	1
Investigation of Entrance of Exhaust Gases With Different Initial Temperatures Into the Air Scoop of a Turbojet Engine.....	2

MARINE AND SHIPBUILDING

The Problems of Developing Commercial Sailing Ships.....	3
A Comprehensive Approach to Refurbishing Ships.....	3
Modern Trends of Increase in the Propulsive Capabilities of Ships.....	4

NUCLEAR ENERGY

Chemical-Technological Conditions in the Period of Starting and Initial Use of an Atomic Power Station With an RBMK Reactor.....	5
Construction of Second Stage of Kola Nuclear Power Plant.....	13
Investigation of Control Rod Vibrations in a Pressurized-Water Reactor in the Channel of a Hydrodynamic Stand.....	14

NON-NUCLEAR ENERGY

Design Study of the Modes of Operation of the Furnace Chamber for the Steam Boiler in an 800 MW Power Unit.....	15
Energy Sources for Underwater Vehicles.....	16

On Calculating the Magnetic Field on the End Faces of the Stator Core and Rotor of a Powerful Turbogenerator.....	16
Development of a Model of Heating of the Rotor of a Power Steam Turbine as Applied to Use in Automatic Systems for Control of Technological Processes in Power Plants.....	17
INDUSTRIAL TECHNOLOGY	
Calculation of Impact Parametric Oscillations.....	18
TURBINE AND ENGINE DESIGN	
Method of Determining the Optimum Axial Clearance in a Turbine Stage.....	19
Calculating the Geometric Parameters of Two- and Three-Dimensional Vaness in the Impellers of Hydraulic Couplings and Other Vaned Machines.....	19
Calculating the Characteristics of a Centrifugal Stage and its Elements.....	20
Choosing an Effective Method of Swirling the Flow in Turbine Blading Design.....	20
End Losses in Transpiration-Cooled Turbine Cascades.....	21
Results of an Experimental Study of Heat Transfer to Turbine Vanes in the Case of Transpiration Cooling.....	21
Concerning One Cause of Arisal of High-Frequency Self-Oscillations.....	22
NAVIGATION AND GUIDANCE SYSTEMS	
Experience With Finishing DAU (Automatic Remote Control) System on the Gas Turbine Vessel 'Kapitan Smirnov'.....	23
Optical Angle Indicator.....	29
Experience in Developing the Remote Automatic Control System for the Kapitan Smirnov Gas-Turbine Ship.....	36
Improving the Quality and Reliability of Ship Control by Using a Turn Indicator.....	36
Choice of Parameters of a High-Frequency Gyroscopic Transformer Current Lead.....	37
Synthesis of an Observing Device to Evaluate the Condition of a Triaxial Gyrostabilized Platform.....	37

Investigation of Dynamic Processes of Thermal Drift of Floating Gyro Instruments.....	38
Concerning Systematic Errors of a Gyropendulum Accelerometer on a Vibrating Base.....	38

FLUID MECHANICS

Resultant Temperature Fields of a Space With a Spherical Cavity.....	39
Temperature Distribution in a Hollow Cylinder With Periodic Volume Heat Release.....	39
Problem of Heat Conduction Involving an Infinitely Large Plate With a Rectangular Foreign Inclusion.....	40
Solution to the Thermal Problem of Evaporation of Conical Solid Bodies in a High-Power Radiation Flux.....	40
Temperature Field of the Active Cell of a Solid-State Laser With a Liquid-Cooling System.....	41
Dependence of Ultrasonic Capillary Rise of a Liquid on its Properties.....	41
Analysis of Heat Losses in the Forechamber of a Gasdynamic Laser During Simulation in a Shock Tube.....	42
Problem of a piston in a Relaxing Gas.....	43
Heat Transfer From a Spherical Source in a Rarefied Gas.....	43
Plotting Curves of Screw Action During Reversing.....	44
Steady-State Waves in a Cylindrical Layer of a Stratified Liquid.....	44
The Problem of Motion of an Ideally Fluid Body in the Field of Gravity of n Stationary Centers.....	45
Hypersonic Flow Around Conical Bodies With Intense Blowing.....	45
A New Device for Dispersing Liquids in Gases.....	46
Characteristic of Effective Emission of the Diffuse Surface of a Cone Irradiated by a Parallel Radiant Flux.....	46
Radiation Properties of a Directionally Emitting Panel Shielded by a Cold Black Screen.....	47
Calculation of Steady-State Harmonic Oscillations of Fluid in Complex Pipelines of Variable Cross Section.....	47

Investigation of Heat Transfer in Barrage Cooling of a Recess in a Supersonic Flow.....	48
Calculation of the Effective Angle of Exit of the Flow From the Runner of a Centripetal Microturbine.....	49
Law of Drag for Turbulent Flow in Rotating Turbomachinery Channels.....	49
Experimental Study of Excitation of Acoustic Vibrations in a Multichannel Burner System.....	50
Vibration Burning of a Gas Suspension of Liquid Fuel Ignited by Flame Jets.....	50
Results of Processing Experimental Data on Heat Transfer in Holes Typical of Turbine Vane Perforations by the Method of Localized Modeling.....	51
Penetration of Cylindrical Solids Into a Compressible Fluid.....	52
Influence of Longitudinal Compression on Unsteady Oscillations of an Elastic Plate Floating on a Liquid Surface.....	52
Some Problems of Penetration of Solids Into a Ponderable Fluid.....	53

MECHANICS OF SOLIDS

Effect of Axial Misalignment of Bearings on the Vibration of Turbomachines.....	54
Natural Transverse Oscillations of Continuous Multispan Beams.....	54
Forced Transverse Steady-State Oscillations of Multiple-Bearing Shafting in Turbomachinery.....	55
Stability of Imperfect Cylindrical Shells Under Two-Parameter Loading Beyond the Elastic Limit.....	56
Solution of Problems of Elastic Twisting of Bodies With Multilayered Cross Sections of Complex Shape.....	56
Optimum Elimination of Vibrations in Plates.....	57
Oscillations of One-Dimensional Systems With a Periodic Potential.....	57
An Energy Criterion of Onset of Self-Oscillations.....	58
Investigation of the Dynamics of a Multilayered Inhomogeneous Hollow Ball.....	59
Concerning the Influence of Weak Anisotropy on the Nature of Propagation of Cylindrical and Spherical Shock Waves.....	59

Influence of Cutouts on the Natural Frequencies of Oscillations of Circular Plates.....	59
Motion of a Three-Degree Mechanical System With Rocking.....	60
Plane Deformation of an Infinite Cylindrical Orthotropic Tube.....	60

TESTING AND MATERIALS

Experimental Evaluation of Methods of Improving the Properties of Titanium Alloys Before Diamond Smoothing.....	61
Highly Effective Diamond Wheel Grinding of Titanium Alloys.....	61
Improving the Durability of Components With Stress Concentrators by Diamond Smoothing.....	62
Optimizing Multilayered Thermal Insulation.....	63

UDC 536.24.08

SOME PROBLEMS OF MAINTAINING TEMPERATURE CONDITIONS IN OPERATION OF FLIGHTCRAFT AND OTHER COMPLEX SYSTEMS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 pp 199-203
manuscript received 2 Jan 80

PANKRATOV, B. M.

[Abstract] The author discusses the advantages of automated data processing in evaluating thermal experiments for aerospace vehicle design. These advantages include speed and accuracy, and also the capability of conducting mass tests under identical conditions in a short period. A brief overview is given of research on modeling temperature conditions on flightcraft, optimum planning of thermophysical measurements, primary and secondary processing of experimental data. An examination is made of general approaches to development of software for data processing in thermophysical experiments. In experimental studies of unsteady heat processes, the thermal boundary conditions and temperature field must be reconstructed inside the sample or model being tested. This problem is reduced to an inverse boundary value problem of thermal conductivity. It can be successfully solved by special gradient methods of minimization in automating the processing of thermal data in design and development of flightcraft and related equipment and systems. [67-6610]

UDC 532.527.004.14

SELF-CONTAINED CASCADE VORTEX SYSTEMS FOR COOLING FLIGHTCRAFT COMPONENTS

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 3, Jul-Sep 80 pp 69-73 manuscript received 29 May 78

MERKULOV, A. P., BIRYUK, V. V. and SMOLYAR, G. A.

[Abstract] The authors consider the feasibility of using vortex tubes to cool airborne electronic equipment by using the velocity head of the incident airstream. Tandem tubes in cascade must be used at flight altitudes up to 20,000 m when the flight speed is Mach 0.5-3.0. A heat exchanger is connected between each pair of

tubes to improve efficiency. The output from the last vortex tube is used to cool the electronic gear. Analysis shows that a two-stage system with acceptable economic performance can stabilize the temperature of operating electronic equipment at a level of 320 K over the entire range of altitudes and flight speeds. Stabilization at 280 K requires a three-stage system. Figures 4, references 4 Russian.
[63-6610]

UDC 629.7.036.018

INVESTIGATION OF ENTRANCE OF EXHAUST GASES WITH DIFFERENT INITIAL TEMPERATURES INTO THE AIR SCOOP OF A TURBOJET ENGINE

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATIONNAYA TEKHNIKA in Russian No 3, Jul-Sep 80 pp 101-103 manuscript received 15 Sep 79

AKHTYAMOV, Z. V. and GILYAZOV, M. Sh.

[Abstract] The use of thrust reversers on commercial aircraft at ground speeds of less than 100-120 km/hr is limited by intake of exhaust gases, causing unstable engine operation. Low-slung engines are worst, as the exhaust jets from the thrust reversers hit the runway airstrip. Because of the variety of thrust reversers on different kinds of engines with different initial temperature of exhaust gases, it is necessary to calculate the potential temperature rise at the engine intake due to entrance of exhaust gases with a change in temperature. In this paper the authors consider the influence of a reverse jet on the quantitative characteristics of exhaust entrance for the case of impact against a runway surface. The study was based on analysis of gas samples from the air scoop. It is shown that the temperature rise can be calculated if the relative fraction of gas by weight that enters the intake device is known. Figures 2, references 3: 2 Russian, 1 Western.
[63-6610]

UDC 629.123.13

THE PROBLEMS OF DEVELOPING COMMERCIAL SAILING SHIPS

Leningrad SUDOSTROYENIYE in Russian No 12, Dec 80 pp 9-12

KRYUCHKOV, Yu. S., SHOSTAK, V. P. and SHEREDIN, V. N.

[Abstract] Because of the current shortage of petroleum, there has been an upsurge of interest in the use of wind power for marine transport. The authors discuss some of the problems that arise in connection with developing up-to-date sailing ships: choice of ports to ensure constant wind speed and direction as well as favorable or neutral currents; choice of cargo to avoid spoilage and to conform to available loading facilities; choice of soft, semi-rigid or rigid sails; hull design; design of wind turbines for charging storage batteries; choice of auxiliary engines; mechanization and automation of setting and furling sails; facilities for maneuvering in ports and narrows. Cost analysis shows that sailing vessels should be competitive with screw-driven ships under a wide range of conditions. Figures 4, references 9: 3 Russian, 6 Western.
[61-6610]

UDC 629.12.004.69

A COMPREHENSIVE APPROACH TO REFURBISHING SHIPS

Leningrad SUDOSTROYENIYE in Russian No 1, Jan 81 pp 41-42

KOSTYUNIN, Yu. K., TKACHUK, A. B. and KHAZANOV, M. Ya.

[Abstract] The authors consider the problems of combining repair and modernization in converting ships for new purposes or updating old ships. It is pointed out that coordination is needed between the planning organizations and the design offices of the ship repair enterprises to complete refurbishing work satisfactorily. Specific examples of work falling short of the mark are given in which antiquated equipment was replaced rather than being repaired. The ship owners must indicate in the technical assignments the specific equipment that is to be replaced or repaired.
[62-6610]

TRENDS OF INCREASE IN THE PROPULSIVE CAPABILITIES OF SHIPS

Leningrad GIDROSTROYENIYE in Russian No 11, Nov 80 pp 7-11

TUMOV, I. A.

[Abstract] The author discusses trends in ship design aimed at maximizing fuel economy by reducing drag and increasing propulsive capabilities of heavy cargo vessels. Bow drag is most radically reduced by using a bulbar nose section. Screw thrust is increased by using tunnels in combination with the screws, and also by increasing the size and reducing the shaft speed of main screws. Propulsive capabilities are also being increased by making more fuel-efficient engines. Some modifications in hull design at the stern end are discussed in connection with new screw designs. Figures 7, references 4: 1 Russian, 3 Western.
[80-6819]

NUCLEAR ENERGY

CHEMICAL-TECHNOLOGICAL CONDITIONS IN THE PERIOD OF STARTING AND INITIAL USE OF AN ATOMIC POWER STATION WITH AN RBMK REACTOR

Moscow ELEKTRICHESKIE STANTSII In Russian No 2, Feb 81 pp 9-11

[Article by V. M. Selez, doctor of technical sciences, P. G. Krutikov, candidate for the degree of doctor of chemical sciences, and G. T. Zolotukhin, engineer]

[Text] The construction and putting into operation of an AES [atomic electric power station] with an RBMK reactor is accompanied by a search for optimal technological conditions. Reliable operation is greatly supported by the selection and organization of chemical conditions during the start-up and initial operation of an AES. For the power units with RBMK-1000 reactors that have been put into operation up to this time, the technological conditions during start-up have been characterized by the data summarized in Table 1.

Table 1

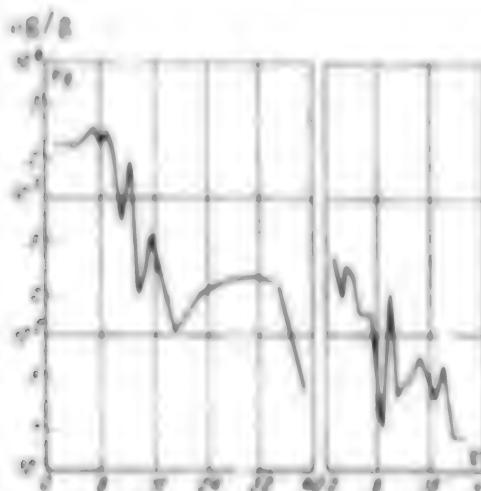
AES	Power unit	Chemical		Year of start-up
		Cleaning	Passivation	
Leningrad	No. 1	Monocitrate of ammonium	Sodium nitrite	1973
	No. 2	(same)	(same)	1975
	No. 3	(not done)*	(not done)	1979
Kurek	No. 1	Trilon B with citric acid	Ammonia	1976
	No. 2	(not done)	Solution of hydrogen peroxide (10 - 20 mg/kg H_2O_2)	1978
Chernobyl ¹	No. 1	Trilon B with citric acid	Sodium nitrite	1977
	No. 2	(same)	(same)	1978

*Scrubbed with chemically desalinated water (0.2-0.05 $\mu S/cm$).

It is clear that the chemical treatment methods (CTM) during the start-up of an AES with an RBMK-1000 reactor are transformed from those used in heat engineering practice (chemical cleanings, passivation with sodium nitrate or ammonia) to CTM on the basis of desalinated water ($\kappa = 0.2-0.05 \mu S/cm$) in the presence of an oxidiser [Ref. 1, 2].

The results of the start-up of later power units with RBMK-100 reactors (Drawing 1) demonstrate that within a relatively short time the indicators of the heat-transfer agent quality and the speed of metal corrosion are established within normal limits.

Drawing 1. Graph of change in the content of iron in the feed water during the initial start-up of power unit No. 3 at the Leningrad AES.



At present it is both possible and necessary on the basis of analysis of the start-up power units and completed research to develop CTM for the start-up period and to outline ways to further improve it.

The purposes of chemical treatment during start-up are to eliminate the contamination of metal surfaces and to minimize corrosion rates during start-up and initial operation of the unit. To achieve these goals the following operations are performed: removal of contamination by chemical diffusion or the kinetic energy of the flow in combination with the thermal influence of the hot water; and reducing the corrosion speeds by creating protective oxide films or by adding anticorrosion properties to the water.

The surface of the AES equipment and tubing, which are manufactured out of pearlite and low-alloy steels, is covered with a layer of various kinds of iron oxides. The amount of oxides, according to data obtained on unit No. 3 of the Leningrad AES, is from 80 to 120 grams per square meter. The basic components are: γ - FeOOH , Fe_3O_4 , α - Fe_2O_3 , γ - Fe_2O_3 .

Electro-chemical research indicates that pearlite steel in this condition has a high corrosion rate [Ref. 3]. These oxides first of all are the remainders of thermic scaling, formed during the production of equipment and tubing and, second, they are the products of corrosion, which appeared during storage and installation. Neither the scaling nor the products of corrosion can serve as the basis for creating a protective oxide film due to the great difference in their structural properties [Ref. 4].

After eliminating most of the pollutants from the condensate-feed loop (CFL) to complete the installation and execution of the start-up operations on other

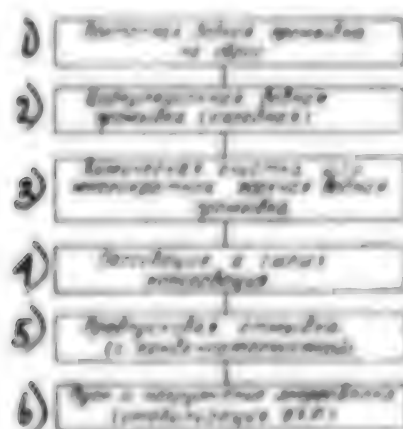
equipment and ducts there must be a pause before putting the CFL into operation. During this time it is advisable to stop work on the CFL.

Following the delay and immediately before the start-up of the turbogenerator (turbine thrust) it is necessary to perform a pre-start flush of the system. Following the pre-start flush when loading the turbine the duct is flushed one last time of all pollutants and the basic indicators of the water-chemical condition (WCC) and corrosion processes are stabilized.

The CTM of the pre-start preparation of metal surfaces can substantially affect the time for stabilizing the chemical processes in the systems and ducts and the continuing capacity of the unit to function.

The CTM is generally constructed in this manner: stage-by-stage rinsing of ductwork to overflow with tap water or chemically demineralized water; the chemical cleaning or hot scrubbing; shutting down of the ductwork; flushing prior to start-up; putting the ducting into operation; and stabilization of the WCC (Drawing 2). The parameters of each start-up CTM are based on construction materials, the technical lay-out and the subsequent operational WCC.

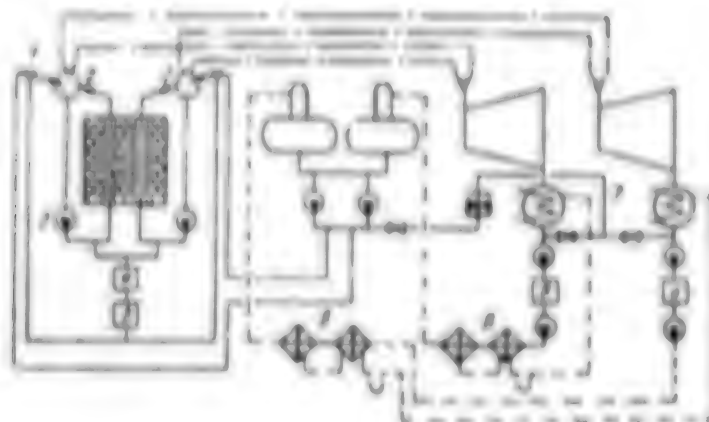
Drawing 2. Basic lay-out of the organization of the CTM during the start-up of an AES with a RBMK-1000 reactor.



Key: 1 - Stage-by-stage rinsing with water to overflow; 2 - Circulating water scrubbing (cold); 3 - Chemical cleaning or repeated hot water scrubbing; 4 - Passivation and (or) shut-down; 5 - Pre-start flushing (with condensate cleaning); 6 - Start-up and loading of the power unit (stabilization of the water chemistry).

Let us consider the water chemistry that is maintained in the condensate-feed loop of operative nuclear electric plants with RBMK-1000 reactors. The equipment that maintains the water chemical condition of the CFL, following the putting into operation of the main power unit with an RBMK-1000 reactor (unit No. 1 at the Leningrad AES - 1973) underwent the following changes: in the condensate cleaner they used mixed action filters (MAF) instead of separate cationite and anionite filters; and operational scrubbing lines appeared in the CFL layout of the Kursk AES and on unit No. 3 of the Leningrad AES. This makes it possible to flush the CFL with the formation of circulation duct (Drawing 3).

Drawing 3. Basic technological layout of a power unit with an RBMK-1000 reactor and two K-500-3000 turbines.



Key: 1 - Mixing unit; 2 - Separator drum; 3 - Main circulating pumps; 4 - Regenerators, pre-coolers of blowdown; 5 - By-pass cleaning of recycled forced circulation duct; 6 - Low-pressure heaters; 7 - Operational scrubbing line; 8 - Condensate cleaning.

The introduction of these filters makes it possible when they are in operation to provide high quality of water following condensate-cleaning: specific conductivity of 0.05-0.1 $\mu\text{S}/\text{cm}$. The use in systems of this quality of water has long held the careful attention of researchers [Ref. 5-7].

It has been shown that electrochemical corrosion processes play a minor role in high quality water, and that the rate of corrosion begins to be controlled by chemical processes with much slower reaction rates. If the specific conductivity of the water is no more than 0.2 $\mu\text{S}/\text{cm}$ and the water contains oxygen in amounts of 0.05-0.50 mg per liter, then at the temperatures typical of the condensate-feed loop not only is there a considerable reduction in corrosion, but a specific surface oxide film is produced with composition unlike that of films produced under other conditions [Ref. 8] (Table 2).

There are usually 50 to 500 $\mu\text{g}/\text{kg}$ of oxygen in the condensate duct of an AES with an RBMK reactor during the start-up and initial operation period. Therefore the water chemistry in the condensate-feed loop can be taken as oxidatively neutral under these conditions.

Table 2

Water condition	Structural composition by layer		
	Outer layer	Internal layer	
		Upper portion	Layer near the metal
Alkaline hydrazine-ammonia	Fe_3O_4 MeFe_3O_4	Fe_3O_4 MeFe_3O_4	Fe_3O_4 MeFe_3O_4
Oxidatively neutral*	Fe_3O_3 $\text{Fe}_3\text{O}_4 + \text{FeO} + \alpha\text{-Fe}$	Fe_3O_4 $\text{Fe}_3\text{O}_3 + \alpha\text{-Fe}$	FeO $\text{Fe}_3\text{O}_4 + \alpha\text{-Fe}$
Oxidatively neutral**	Fe_3O_3 $\text{Fe}_3\text{O}_4 + \text{FeO} + \alpha\text{-Fe}$	Fe_3O_4 MeFe_3O_4	FeO Fe_3O_4

* Determined with the use of fluoroscopy.

** Determined with the use of electron diffraction.

Knowing the status of the initial surface, the surface in operation and the water chemistry in the CFL, one can assign the parameters of the stages of the CTM during start-up (See Drawing 2). Let us begin our examination with the last technological operation.

During the start-up and loading of the turbine the CFL operates in a neutral mode with water of a high degree of purity ($\sigma = 0.05\text{--}0.2 \mu\text{S/cm}$) with 50-500 $\mu\text{g/kg}$ of oxygen. Therefore the flushing of the CFL which precedes the start-up, requires water of the same degree of purity.

The timely switching on of the condensate cleaner ensures the needed quality of the condensate. The availability in the system of operational scrubbing lines makes it possible to have a closed circulation, while by-passing the turbine condensers and nearly eliminating temporary tubing systems.

The water used to fill the CFL is usually saturated with oxygen. During the scrubbing process it is advisable to proportion the oxygen (or other oxidizer, for example H_2O_2). Flushing must be done at a temperature of 45-55 degrees C. (temperatures greater than this prevent acidification) with the condensate cleaner operating for 12 to 24 hours.

The delay between chemical cleaning (or preliminary hot scrubbing) and start-up is from 2 to 4 weeks. Therefore, the ducting for this period of time must be shut down and passivated with water oxidizer solutions (hydrogen peroxide, oxygen). Prior to this and following the installation, pollutants must be eliminated from the surface of the ductwork and equipment. The remainders of scaling and other corrosion products should be eliminated chemically (washing compositions based on chemical complexes).

When doing a good job of eliminating scaling and the subsequent shutdown of power plants, it is possible to replace chemical cleaning with repeated scrubbing with hot (90-100 degrees C.) water. This is preceded by a cold scrubbing, by means of which foreign matter is removed from the surface of equipment and the tubing system.

CONCLUSIONS

1. The proposed technology provides both the rapid attainment of standard WCC indicators and through passivation the minimal speed of corrosion of construction materials during operational and transient conditions.
2. On the basis of this technological layout it is possible to further improve the CDM, which makes it possible during start-up to reduce the maximum content of iron in the water to 100 $\mu\text{g/kg}$ and to provide after several hours of operation a stabilized iron content at a level of 1-3 $\mu\text{g/kg}$.

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correction. *Energizdat*. "Elektricheskiye stanitsii", 1981

88/27

(20) 8144/0820-4

CONSTRUCTION OF SECOND STAGE OF KOLA NUCLEAR POWER PLANT

Budapest ENERGIA EN ATOMTECHNIKA in Hungarian Vol 33, No 11, Nov 80 pp 522-525

VOLEKOV, A. P., director of the nuclear power plant in Kola, USSR

[Abstract] The second stage, designed by the Leningrad branch of the Teploelektroproyekt Institute, will increase the output of the power plant of 1,760 MW by the installation of two Type VVER-440 reactors and associated equipment. The construction of the second stage is scheduled for completion in 1981. Approximately 50 percent of the work is done by the power plant's construction directorate; the other 50 percent is done by subcontractors. The construction directorate has obtained much new equipment and has introduced major improvements in its operations to permit this work to be performed. Maximum mechanization of the construction work, much preassembly of piping systems and the like, and the use of trained personnel will contribute to the high quality and timely completion of the construction, which so far is on schedule. The extensive documentation for the second stage of the power plant was prepared by the management of the plant. The management also handles testing and acceptance of deliveries, release of sections for operation, consultation with the builders, and startup operations. A total of 826 construction workers, 101 specialist workers, 50 electricians, and 17 insulation installers are employed on the project. At the present time, construction of the main building is almost completed, and approximately half of the approved funding has been expended. Radioactivity instruments are used widely in testing subassemblies for leaks, and automated welding is used wherever feasible. Each and every test report (together with radiographs and charts) is preserved to document the performance of the individual subunits. The excellent organization of the work teams and the working procedures contributes to the successful progress of the project. No references.

[2502/47-2542]

INVESTIGATION OF CONTROL ROD VIBRATIONS IN A PRESSURIZED-WATER REACTOR IN THE CHANNEL OF A HYDRODYNAMIC STAND

Moscow ATOMNAYA ENERGIIYA in Russian Vol 50, No 1, Jan 81 pp 62-64

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ANDRYUSHENKOV, I. N., BULAVIN, V. V., VLADIMIRTSEV, S. I., KARMANOV, F. V., LUNIN, G. L., SMOLYAR, A. G., FEDOROV, V. G., SMIRNOV, A. I. and CHUFISTOV, V. A.

[Abstract] Dynamic displacements of the control rod in a VVER-440 reactor are studied in the channel of a hydrodynamic stand as a function of the flowrate and inlet conditions for the coolant stream. At the same time, a study is done on the way that the parameters of control rod vibration are related to the hydrodynamic characteristics of the flow. The channel of the stand reproduced the conditions of coolant flow around the control rod that take place in the reactor core. The overall flowrate of water through the channel was controllable. Measurements were made of the coolant flowrate through the channel, the amplitude and spectral distribution of pressure pulsations in the coolant, the amplitude and spectral distribution of control rod displacements. Pressure pulsations in the flow were measured by induction sensors at the inlet, outlet and middle of the channel. Rod displacements were measured by induction sensors and by a non-contact acoustic method. With symmetric inlet of the coolant through uniformly spaced holes in the bottom of the cylinder, coolant flow around the rod was uniform. With asymmetric inlet over half of the cylinder, the rod was pressed against the inner wall of the channel, and the amplitude of vibrations was considerably reduced. The spectrum of pressure pulsations up to 50 Hz was nearly independent of flowrate from 85 to 140 m³/hr. With symmetric inlet, most of the power of the pulsations falls in the range of frequencies up to 5 Hz. Maximum power of pressure pulsations is reached at about 1 Hz, and the amplitude is 17709.98 Pa. Asymmetric inlet reduced the power of pressure pulsations up to a frequency of 5 Hz. Figures 4.

[64-6610]

UDC 621.181.7.001.24

DESIGN STUDY OF THE MODES OF OPERATION OF THE FURNACE CHAMBER FOR THE STEAM BOILER IN AN 800 MW POWER UNIT

Moscow TEPLOENERGETIKA in Russian No 2, Feb 81 pp 39-43

MITOR, V. V., doctor of technical sciences, SHAGALOVA, S. L., candidate of technical sciences, PARSHIKOV, D. I., engineer, KHRISTICH, L. M., engineer, PARFAROV, D. I., candidate of technical sciences, and FEDOTOV, P. N., engineer, Scientific-Industrial Association, Central Institute of Boilers and Turbines Planning Department, "Krasnyy Kotel'shchik" ("Red Boiler Builder")

[Abstract] A boiler delivering steam at a rate of 2650 metric tons/h (pressure 25 MPa, intermediate superheat temperature 545/545°C) with scale removal has been developed with a furnace burning the low-grade gaseous acidic slowly caking Kuznetsk-basin coal and the low-grade gaseous Donets-basin coal dust. This TPF-804 boiler has a T-shape integral construction with flue gases exhausting on the narrow side. A design analysis had been made, for the purpose of optimizing its performance, to determine the dependence of the full combustion dynamics and of the temperature distribution in the furnace on the operating parameters as well as on the locations of fuel and air inlets, also on the location of the flue gas reentry. The burner system consists of 48 elements producing a more easily regulated flat flame rather than a swirling flame, 12 elements per stage in pairwise opposing 4 stages, with the excess air optimized within 1.1-1.3 and with the degree of fuel comminution depending on the volatiles content in the coal optimized for minimum mechanical undercombustion. Owing to the particular characteristics of the given grades of coal, optimization also had to include a tradeoff to meet two opposing requirements, namely stable combustion under a light partial load and prevention of slag buildup under a nominal full load. Figures 7; tables 3; references 4 Russian.
[79-2415]

ENERGY SOURCES FOR UNDERWATER VEHICLES

Leningrad SUDOSTROYENIYE in Russian No 11, Nov 80 pp 12-15

KVANTALIANI, N. Ye.

[Abstract] An examination is made of the advantages and disadvantages of energy sources presently being used on underwater vehicles. Until recently, lead-acid storage batteries were assumed to be the only suitable source for such applications. Silver-zinc, nickel-cadmium and nickel-iron batteries are used only rarely for underwater vehicles, mainly because of high cost factors. There has been a recent upsurge of interest in nickel-zinc batteries as energy sources on underwater vehicles. These batteries had hitherto been considered unsuitable because of their short service life, but there is now a good outlook for improvement of this parameter. In addition to batteries, hydraulic drives are used for sources of energy in underwater applications, the main disadvantage of such drives being low efficiency of energy conversion. Hydraulic drives are mainly used for moving control surfaces, auxiliary winches, manipulators and the like, although they have been used for the main propulsion unit, for example on the Mermaid. When the engineering problems of making lithium anodes have been solved, it should be possible to make storage batteries for underwater work with specific energy capacity of 600 watt-hours per kg or more. The future energy source that is closest to realization at present is the sodium-sulfur storage battery that will have a specific energy capacity of 250-300 watt-hours per kg. Fuel cells are also being developed for underwater use. Depending on specific applications, hydrogen-oxygen fuel cells could have specific energy capacities ranging from 100 to 500 watt-hours per kg. Closed-cycle gas and steam turbines are another possibility for future use underwater. References 12: 7 Russian, 5 Western.

[60-6610]

ON CALCULATING THE MAGNETIC FIELD ON THE END FACES OF THE STATOR CORE AND ROTOR OF A POWERFUL TURBOGENERATOR

Kiev TEKHNIЧЕСКАЯ ЭЛЕКТРОДИНАМИКА in Russian No 5, Sep-Oct 80 pp 61-65
manuscript received 11 Feb 80GORBATYUK, M. F., SMORODIN, V. I., KARATSUBA, A. S. and YAKOVLEV, V. I.,
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[Abstract] The electromagnetic field distribution in the end region of a turbo-generator is determined by the geometric complexity of the design, and also by the nonlinear and tensor properties of the permeability and conductivity of the components. Considerable difficulties are involved in accounting for all characteristics of the medium both in finding the mathematical solution of the problem

and in developing a computer algorithm. In this paper the authors suggest a method of conformal mapping for calculating the magnetic field on the surface of the stator core and the steps of the end stacks in the no-load operation of a turbogenerator. The proposed method is used for calculating the field distribution in the TGV-500 MW turbogenerator, and the results are compared with experimental data. It is shown that the method can be used for simplified approximate calculation of the magnetic field on the surface of the rotor in an induction turbogenerator with field excitation by the stator winding. (10 references 5 Russian. [40-6610])

UDC 621.165.62-57.011.56

DEVELOPMENT OF A MODEL OF HEATING OF THE ROTOR OF A POWER STEAM TURBINE AS APPLIED TO USE IN AUTOMATIC SYSTEMS FOR CONTROL OF TECHNOLOGICAL PROCESSES IN POWER PLANTS

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 12, Dec 80 pp 46-50 manuscript received 29 Nov 79

PRIGORILER, V. L., candidate of technical sciences, docent, GALTUULIN, N. G., and SHKLYAR, A. I., engineers, Ural Polytechnical Institute imeni S. M. Kirov, Uraltekhenergo

[Abstract] Unsteady temperature stresses in the rotors are a major factor in limitation of the rate of heating or cooling in present-day high-power steam turbines. One of the ways to study the thermal state of the rotor is the development of digital models of the rotor heating process based on the computer information systems incorporated in the automated process control systems of power plants. This paper offers an improved model of rotor heating in which it is assumed that maximum temperature stresses in the rotors arise at the inlet to the forward (intermediate) end seals in the zone of maximum steam temperatures, high heat transfer and stress and strain concentration. The method of development is based on the concept of lattice functions. Expressions are derived for the temperature field in the rotor and the temperature gradient on the heated surface as a function of the temperature behavior of the heated surface. The proposed method of computer control enables optimization of starting conditions with consideration of the thermal state of the rotor. The input signals are the steam temperature in the regulating stage and the rpm and load on the turbine shaft. Figures 2, references 5 Russian. [45-6610]

CALCULATION OF IMPACT PARAMETRIC OSCILLATIONS

Leningrad IZVESTIYA VYSSHIYE UCHEBNYKH ZAVEJENIY: PRIBOROSTROYENIYE in Russian
Vol 13, No 12, Dec 80 pp 30-33 manuscript received 21 Jan 80

OSTROVSKIY, V. Ya. and CHECHURIN, S. L., Leningrad Polytechnical Institute
Imeni M. I. Kalinin

[Abstract] An examination is made of dynamic systems in which oscillations are excited by a periodic stepwise change in a parameter. An approximate frequency method is used to analyze the conditions of excitation of impact parametric oscillations in a pulse system in which a switch is periodically closed for a given time with known period, and the linear continuous part of the system has a known transfer function. The output signal has a spectrum that contains some fundamental frequency plus frequencies that are multiples of the switch closing rate. Approximate conditions are found for excitation of oscillations with half the switching frequency, assuming that the linear part of the system has the property of a filter and harmonics with frequencies that are odd multiples of half the switching frequency are small. A simple geometric illustration is given of conditions of excitation in the coordinate plane of a Nyquist hodograph. Figures 2, references 6 Russian.
[70-6610]

TURBINE AND ENGINE DESIGN

UDC 621.135.253

METHOD OF DETERMINING THE OPTIMUM AXIAL CLEARANCE IN A TURBINE STAGE

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 73-77
manuscript received 23 Jan 79

LASKIN, A. S., Leningrad Polytechnical Institute

[Abstract] A method is proposed for determining the optimum axial clearance in a turbine stage that maximizes the efficiency of the stage. The analysis is semi-empirical, being based on experimental data in which the optimum axial clearance had not been determined, but all required data were available for calculating it. Calculated values are in agreement with experimental data. Figures 3, references 8 Russian.
[58-6610]

UDC 621.22

CALCULATING THE GEOMETRIC PARAMETERS OF TWO- AND THREE-DIMENSIONAL VANES IN THE IMPELLERS OF HYDRAULIC COUPLINGS AND OTHER VANED MACHINES

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 87-94 manuscript received 22 Apr 78

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[Abstract] The author considers the design of flat blades for hydraulic couplings, clutches, pumps and blowers. Equations convenient for computer utilization are derived that show the relations between geometric parameters of a blade. The resultant expressions can be used to calculate the angle between any two vectors, which in general can be independent of the coordinate axes used in determining the geometry of the blading. A total of 15 angles can be defined by using six vectors taken in pairs. It is shown that the initial equations used for a flat blade can be generalized to a three-dimensional blade. Figures 2, references 5 Russian.
[58-6610]

CALCULATING THE CHARACTERISTICS OF A CENTRIFUGAL STAGE AND ITS ELEMENTS

Minsk IZVESTIYA VYSHNIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 12,
Dec 80 pp 51-56 manuscript received 17 Mar 80

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candidate of technical sciences, and ROSSEL', V. V., engineer, Leningrad
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[Abstract] A method is proposed for element-by-element calculation of the characteristics of the impeller and vaned diffuser in a centrifugal compressor stage. On the basis of techniques developed at Leningrad Polytechnical Institute for calculating the characteristics of an impeller, and of vaned and bladeless diffusers, the authors propose a method of calculating the characteristics of two-section stages with vaned and bladeless diffusers in the third and fourth sections. Comparison with experimental characteristics shows good agreement. Figures 4, references 6 Russian.
[45-6610]

UDC 621.438

CHOOSING AN EFFECTIVE METHOD OF SWIRLING THE FLOW IN TURBINE BLADING DESIGN

Kazan' IZVESTIYA VYSHNIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 9-13 manuscript received 19 Nov 79

ABDNOV, B. M. and KERZHENKOV, A. G.

[Abstract] An analysis is made of the relationship between the mass of shrouded blading and the method of swirling in gas turbine design. The study is based on comparing working blade designs for the two most widely used principles of flow swirling: maintaining constant angle of flow in front of the runner and maintaining constant product of peripheral velocity and radius. Variables are the relative length (ratio of blade height to average diameter of the flow section) and kinematic parameters on the average diameter of the flow section. The mass difference for the different methods of twisting depends on the triangle of velocities on the average radius, and the length of the profile section. It is found that in most cases the swirling principle based on maintaining constant product of peripheral velocity and radius is preferable in profiling turbine blades to optimize mass of the blading. Figures 4, references 4 Russian.
[63-6610]

END LOSSES IN TRANSPIRATION-COOLED TURBINE CASCADES

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 46-49 manuscript received 14 Jul 79

YERIFANOV, V. N. and GUS'KOV, V. I.

[Abstract] As a first stage in studying the feasibility of sweat-cooling vane in turbomachinery cascades, detailed experiments have been done on the influence that various working parameters of straight gas turbine cascades have on end losses. These experiments were done on a special stand described by the authors in another paper. This article is limited to description of the components directly involved with the measurement of end losses. The distribution of the specific mass flow-rate of coolant with respect to vane height was studied for end feed and side feed of the coolant. The distribution of total pressure over the height of the vane in the flow behind the cascade was measured by an unoriented fifteen-channel Pitot tube. All major experiments on determining energy losses were done for coolant flow through the vane surface up to 41. The coefficient of end losses was calculated as the difference between the coefficient of losses in the cascade and the coefficient of profile losses. It was found that an increase in the average flow-rate of coolant through the porous blade surface leads to a linear increase in the coefficient of end losses, and the slope of the line is steeper for vanes with a smoother surface. Figures 3, references 7: 5 Russian, 2 Western. (63-6610)

UDC 621.438.253

RESULTS OF AN EXPERIMENTAL STUDY OF HEAT TRANSFER TO TURBINE VANES IN THE CASE OF TRANSPIRATION COOLING

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 109-112 manuscript received 23 May 79

DEZIDER'YEV, S. G., KARIMOVA, A. G. and LOKAY, V. I.

[Abstract] The temperature conditions of hot turbine components in the case of transpiration cooling can be reliably calculated only if accurate information is available on the boundary conditions of heat exchange, and specifically on the intensity of heat transfer from the gas to the surface being cooled. The authors give data from hydraulic tests of porous specimens and investigate internal heat exchange. The results of experiments on the concave and convex surfaces of vanes show that transpiration cooling can increase the intensity of heat transfer as compared with heat transfer to a permeable surface for low values of the blow-in parameter

$$b_t = \frac{(\rho w)_a}{(\rho w)_g \cdot St_0}, \text{ where } (\rho w)_g, (\rho w)_a \text{ are the density of mass}$$

flow of gas and oil respectively, and St_0 is the Stanton number for the case without blowing. The experimental results are approximated by the formula

$$Nu_{\omega} = 0.019 Re_{\omega}^{0.8} Pr_1^{-0.9} \text{ for local Reynolds numbers of } 1.6 \cdot 10^5 - 1.3 \cdot 10^6 \text{ and}$$

$$Pr_1 = 0.4 - 3.5. \text{ Figures 4, references 8 Russian.}$$

[63-6610]

UDC 629.7.036

CONCERNING ONE CAUSE OF ARISING OF HIGH-FREQUENCY SELF-OSCILLATIONS

Качан' IZVESTIYA VYSSHEKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 116-118 manuscript received 19 Apr 79

PAVLOVERKIY, V. P.

[Abstract] Cases have been observed where an increase in pressure on the fuel injection nozzles of aircraft engines by a factor of 1.5-2 leads to high-frequency self-oscillations in transient modes without causing high-frequency instability under steady-state conditions. The author attributes this effect to disintegration of an annular gas bubble in the nozzle of the oxidant injector that initiates hard excitation of unstable combustion due to entrainment of the vapor phase. Tests are done that confirm the controlling effect of the rate of increase in oxidant flowrate and the ratio of gas pressure in the combustion chamber to the pressure preceding the oxidant injector on the onset of unstable combustion due to disintegration of the gas bubble. Figures 4, references 5 Russl.-. [63-6610]

EXPERIENCE WITH FINISHING DAV (AUTOMATIC REMOTE CONTROL) SYSTEM ON THE GAS TURBINE VESSEL 'KAPITAN SMIRNOV'

Leningrad SUDOSTROYENIYE in Russian No 1, Jan 81 pp 24-26

[Article by V. A. Andreev, V. V. Voytetskiy, B. D. Remisov and A. I. Shrayer]

[Text] Development of a series of domestic gas turbine vessels with horizontal cargo handling advanced a number of problems, among which one of the most complex was development of a system of complex automation of gas turbine-gear units with heat utility circuit (TUK) which provides operation of EU [Power plant] without a constant watch in the MKO [Engine and boiler room], which corresponds to feature of automation A2 of the USSR Registry in the symbol of class of ship [1]. The composition and structure of the GTU [Gas turbine engine] control complex were determined by its thermal circuit and by the characteristics of the main equipment [2]. The complex includes the following systems: automatic remote control of the power plant (the Raskat DAV), starting and protection of the GTD [Gas turbine engine] and TUK, remote control of the fittings and mechanisms of the GGTA with TUK and the fuel system, regulation of the parameters of the steam-water cycle and actuating, emergency and warning signalling and recording of parameters of the power plant.

The problems related to regulation, adjustment and turnover of the DAV system on a ship are considered in the present article. The range of problems related to finishing the remaining systems of the GTU control complex was mainly solved during testing of the unit under bench conditions and is not considered in the article.

The Raskat DAV system includes the following devices: control consoles in the wheelhouse and in the TsPU [Central control console] and actuating mechanisms. A block diagram of the Raskat system is shown in Figure 1. Control is accomplished from the wheelhouse (Figure 2) by the levers of engine telegraphs which are kinematically connected to rotating transformers, which are the control sections of the electromechanical tracking drive. The drive includes program and amplification blocks and an actuating mechanism, the output shaft of which is connected by a connecting rod to the GTD gas sector.

A profile cam was introduced to the kinematic links connecting the output shaft of the engine telegraph with the controller to provide the necessary type of control characteristic ($\alpha_{in} = f(\alpha_{out})$, where $\alpha_{out} = \alpha_{in}$ are the angles of rotation of the engine telegraph lever and the output shaft of the actuating mechanism, respectively, during forward and reverse running of the ship. Engine reverse during control

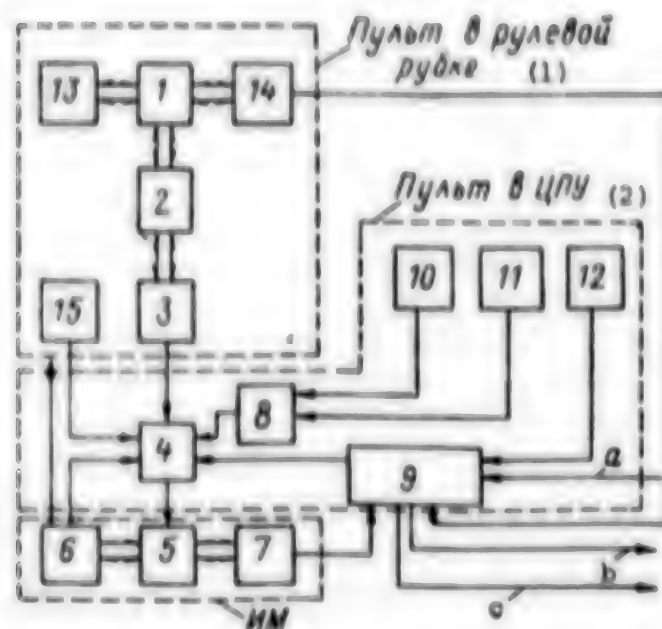


Figure 1. Block Diagram of Raskat NAU System for Control of GGTA of One Side: 1--engine telegraph (MT); 2--profile cam; 3--controller; 4-- program and amplification block; 5--actuating mechanism (IM); 6--feedback block with location, position and speed feedback sensors; 7--microswitch block; 8--pressure control block; 9-- logic part of diagram; 10--IM stop controller for forward running; 11--IM stop controller for reverse running; 12--"port-sea" switch; 13--reversograph sensor; 14--MT microswitch block; 15--"stop-screw" controller; a--information on status of reverse members; b--instructions on control of reverse members; c--instructions on control of steam turbine

Key:

1. Console in wheelhouse

2. Console in TsPU

from the wheelhouse is also accomplished from the engine telegraph lever, the output shaft of which is connected to the reversograph sensor and to the microswitch block, forming instructions to move the reverse members of the GTD to the "forward running" (PKh), "reverse running" (ZKh) and "stop-screw" (SV) positions. The logic circuit of the Raskat system provides switching from one control program of the actuating mechanism (IM) to another and automatic execution of the "port" and "sea" modes and the reverse algorithm by signals from the microswitch block of the actuating mechanism, the engine telegraph and the "port-sea" switch by means of the program blocks [1].

All the functional blocks of the Raskat system are arranged on the console in the TsPU. The engine telegraph transponders, instruction mechanisms of the cable control lines of the gas sector, the "port-sea" switch, controllers of the regulated IM stop, other instruction members and the actuating signalling board are also located here.

Remote control of the pressure of each IM separately in the PKH and SKH zones permits one to limit the range of variation of GTD power, based on concepts of eliminating overloads of the GTD as a function of operation conditions (ambient air temperature, clogging of the flow-through part of engines, the composition and mode of the operating plant and so on). The stop is regulated by the rotational frequency of a high-pressure compressor, according to available calculating graphs.

When adjusting the Raskat DAU on a bench together with the GGTA M25, a number of problems related to providing the essential efficiency of the system was solved. The static and dynamic properties were solved. The accuracy of the tracking line comprised ± 1 percent by the position of the gas sector over the entire range of rotation and did not exceed 0.02 deg/s by its rate of shift with respect to the given program. The logic part of the system provided reliable finishing of the algorithm during reverse, emergency dumps of fuel feed, switches from the "port" to the "sea" mode and reverse and from one type of fuel to another and also formation of the required signals to related control systems.

The static characteristics of the entire engine-impeller complex of the gas turbine vessel "Kapitan Smirnov" were analyzed during adjustment of the Raskat DAU on the ship. A fuel-regulating apparatus with all-mode fuel consumption regulator was installed on the M25 unit. The corresponding static characteristics were $N = f(n_{gv})$ and $n_{im} = f(n_{gv})$, where N is the output of the GGTA and n_{gv} is the rotational frequency of the screw, taken at ambient air temperature of approximately 0°C (Figure 3). It is obvious from the figure that the position of the static characteristic depends on the parameters of a specific turbounit, a specific block of the fuel-regulating apparatus, shafting and the composition of the operating EU. It is known that the type of static characteristic is also dependent on the state of the flow-through part of the GTD and on atmospheric parameters.

As already pointed out, the characteristic feature of the Raskat DAU system is combining in one design the engine telegraph levers and the GGTA operating mode controller. Clearly defined conformity between the course controlled by the engine telegraph and the operating mode of the unit by the rotational frequency of the shaft should be provided. As follows from analysis of the curves (Figure 3), the control characteristic will not be clearly defined and requires manual correction to provide the necessary value of n_{gv} according to the course table.

Moreover, any variation of the GGTA control characteristics leads to the need to readjust the control system by replacing the cam profile of the DAU mode control mechanism. Total conformity of the GGTA characteristics and the Raskat system is provided only with the presence of a control circuit n_{gv} in the DAU system [3].

The essential efficiency of the screw shaft rotational frequency control circuit was checked during sea trials of the gas turbine vessel "Kapitan Smirnov." A mock-up of the frequency controller realized the integral law of its regulation and the regulator was made in the form of a corrector to the main signal for control of the gas sector position. The corrector was switched on after reducing the error signal between the given and actual rotational frequency to specific limits. The transient process in the circuit was monotonic in nature and there was no re-regulation by the main GTU parameters. The integration time constant was taken as sufficiently large to damp the disturbances introduced by the control circuit n_{gv} .

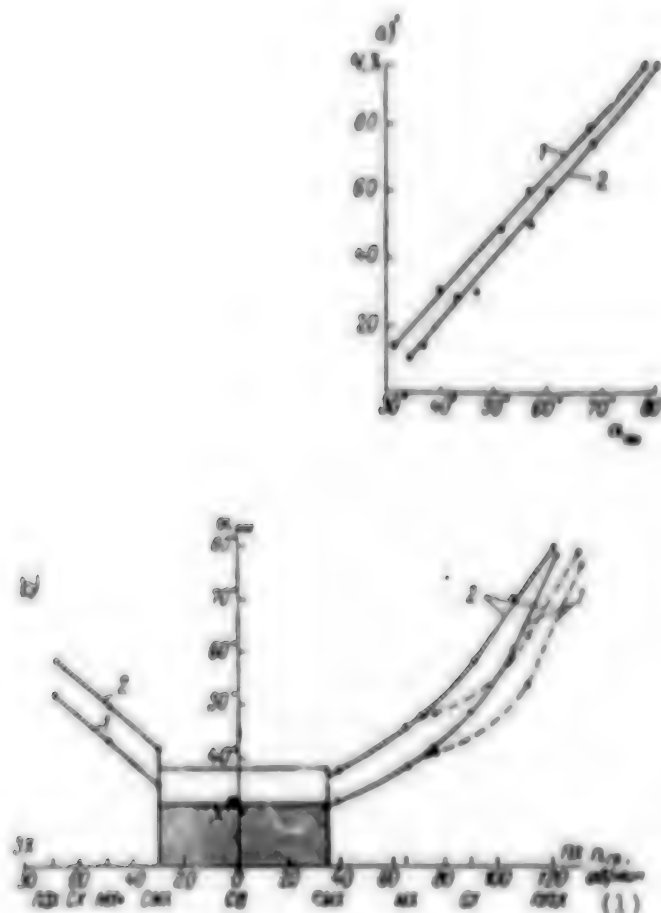


Figure 3. Static Characteristics of Engine-Propeller Complex of Gas Turbine Vessel "Kapitan Smirnov": a--characteristic $Q = f(\alpha_{1m})$; b--characteristic $n_{gv} = f(\alpha_{1m})$; 1 and 2--GTD of left and right side, respectively; α_{1m} --angle of rotation of output shaft of actuating mechanism; PPKh and PZKh--full forward and full reverse running

Key:

1. rpm

to the gas-generating part of the GTD. The gas sector switching programs in the "port" and "sea" modes provided smooth course of the transient processes according to the given rate of maneuvering. When the engine telegraph lever is set to full forward or full reverse, the previously regulated IM stops provided reliable automatic maintenance of the gas sector in the positions which eliminate operation of the unit in the impermissible range of variation of the main GTU parameters, including during action of the corrector n_{gv} during maneuvering.

Some characteristics of the EU were determined during finishing of the reverse modes of the engine-propeller complex which determine the main maneuvering characteristics of the ship. The transient processes during reverse were recorded on an oscillograph. The following were taken as the parameters which determine the quality of the processes: the angle of rotation of the output shaft of the actuating mechanism, the rotational frequency of the high-pressure compression shaft and of the right and left propeller shafts.

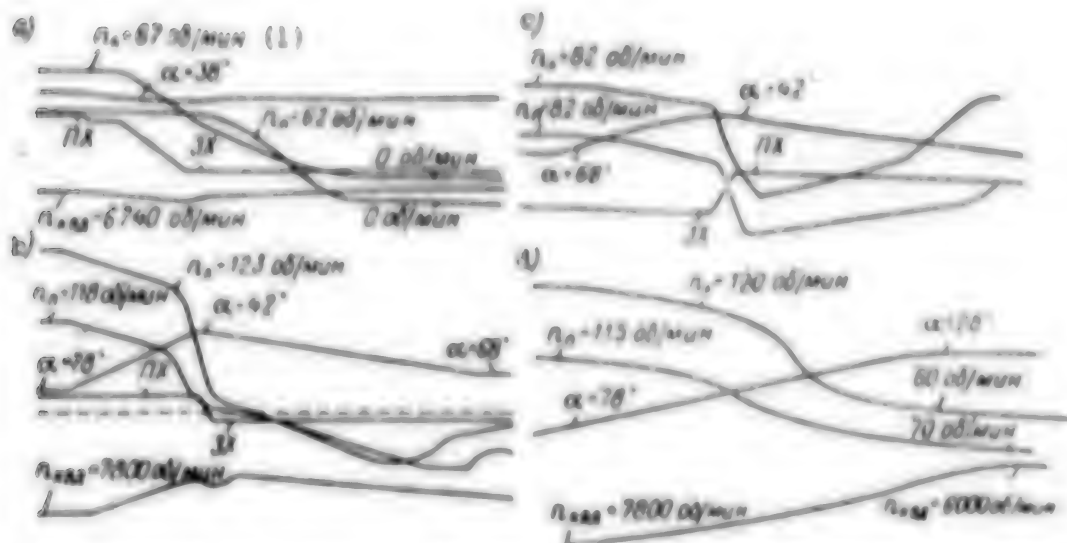


Figure 4. Transient Processes in Engine-Impeller Complex During Control of M-25 Units from Raskat DAI: a--MPKh-MZKh reverse; b--PPKh-PZKh reverse in "port" mode; c--PZKh-FPKh reverse in "port" mode; d--PPKh-SV maneuver in "sea" mode; MPKh and MZKh--slow forward and reverse.

Key:

1. rpm

It was possible to maintain "zero" rotational frequency with the ship in a fixed position and specifically during berthing by selecting the corresponding position of the gas sector in the "stop-screw" mode (Figure 4). Reverse maneuvers were carried out in the entire range of the engine telegraph from PKh to ZKh and reverse in the "port" mode and under full speed and by the "sea" program. Analysis of the transient processes showed that reverses at full speed are satisfactory and that the required maneuvering qualities of the ship are provided. However, a delay in the time that the propeller shaft rotational frequency is in the "zero" position was observed during reverse at the slowest "forward" speed to the slowest "reverse" speed (or from slow "forward" to slow "reverse") (see Figure 4), which significantly delayed maneuvering during berthing. Some delay at the "zero" rotational frequency was observed during all reverses from PKh to ZKh if the given speed of ZKh was below the initial speed in forward running. The phenomenon described above should be manifested to a greater extent as the load of the ship increases. This is explained by the relatively low output of the reverse speed turbine required to achieve n_{gv} corresponding to SMKh and MKh modes. To localize the indicated phenomenon, it is recommended that the engine telegraph lever be set to the reverse speed position exceeding the given speed (in SKh or PZKh) after the reverse members have been switched and that it be moved to the given reverse speed position only after the direction of propeller shaft rotation has been changed.

Conclusions. Sea trials of the gas turbine vessel "Kapitan Smirnov" and its first operational voyage confirmed the efficiency of the Raskat DAI system, the efficiency of control of GTU maneuvering modes from the wheelhouse during berthing, passage through narrow straits and during prolonged steady full speeds. At the

same time, the experience of development and finishing of the Rankat DAU system shows that increased requirements should be placed on provision of the clearness of the characteristics by which they are combined with the DAU system during subsequent realization of the control system from the wheelhouse to local automatic circuits. Another solution will be to include a regulator-corrector in the DAU system which realizes the integral law during change of mode. The structure should be changed in this regulator during reverse to SM and MPH "reverse" as a result of switching off the integral part. Because of this, it will function like an ordinary high-speed propeller shaft rotational frequency regulator.

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CSO: 8144/0756

OPTICAL ANGLE INDICATOR

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE (in Russian)
Vol. 23, No. 12, Dec. 80 pp. 63-67 manuscript received 8 Aug. 78

[Article by V.A. Chistyakov, Moscow Higher Technical School (Imeni N.E. Bauman)]

[Text] The design of an optical angle indicator for a vibratory gyroscope is discussed. The key characteristics and the results of experimental investigations of a simulated model of the angle indicator are presented.

In the creation of vibratory gyroscopes the need arises of measuring angular displacement of the rapidly turning rotor [1]. The angle indicators used in vibratory gyroscopes are as a rule of the inductive or capacitive type [2]. These indicators are complicated to make, have poor metrological characteristics and can create harmful moments acting around the axes of the gyroscope's suspension.

At the present time optical angle indicators are used widely in various engineering fields. Unlike inductive and capacitive, optical indicators are simple to make, since they are built from elements series-produced by industry, are of a small size and do not create harmful moments.

The design of an optical angle indicator for a vibratory gyroscope is illustrated in fig. 1. It consists of a light source, 2, (an OPZ-0,25 incandescent lamp), a four-stage photodiode of the FD-19KK type, 3, and a spinning rotor, 1. In the rotor have been drilled holes through which the light flux from the light source is admitted to the photodiodes. As the rotor spins around axis OX, the light spot moves over the surface of the photodiodes. As the result of this, the output signals from photodiodes 1 and 2 (cf. fig. 2) become nonidentical. The summation of signals is performed by means of the differential amplifier illustrated in fig. 3.

The output voltage of the angle indicator is proportional to the difference of the areas illuminated by the light flux on the surface of the photodiodes:

$$U_{\text{out}} = K_a \left(U_1 \frac{S_1}{S} - U_2 \frac{S_2}{S} \right).$$

(1)

where K_A is the amplifier's transfer constant; S_1 and S_2 represent the area of the light spot on the surface of photodiode 1 and 2, respectively; S is the area of the light spot on the surface of the photodiodes ($S = \pi R_H^2$); and U_1 and U_2 are the output voltages of photodiodes 1 and 2 with $S_1 = S_2 = S$.

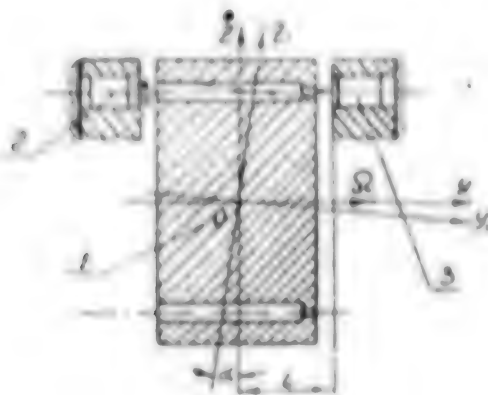


Figure 1.

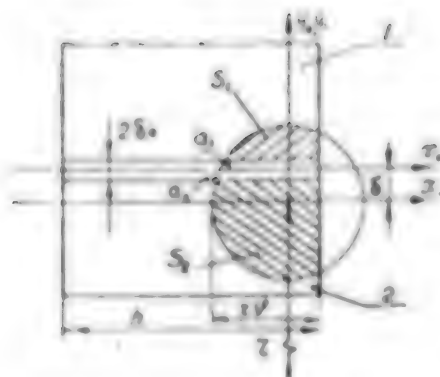


Figure 2.

For multistage photodiodes we have the condition

$$U_1 \approx U_2 = U_0$$

When the rotor is spinning the angle indicator's output signal is in the form of pulsed current.

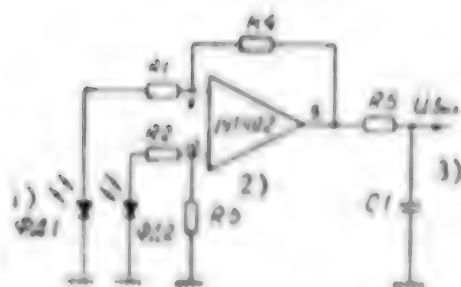


Figure 3.

Key:

- 1. FD1 [photodiode 1]
- 2. IUT402

3. U_{vykh} [output]

The duration of the pulses equals

$$t_p = \frac{h + 2R_g}{\Omega r}, \quad (2)$$

where h is the width of the photodiode stage (cf. fig 2); R_g is the diameter of the light spot; Ω is the angular rotational velocity of the rotor; and r is the distance from the axis of rotation to the center of the holes.

The pulse repetition rate equals

$$T_p = \frac{2\pi}{i\Omega}, \quad (3)$$

where i is the number of holes in the rotor.

For the purpose of determining areas S_1 and S_2 , whose value depends on the relative position of the rotor and photodiodes, let us employ the following coordinate systems: Ox_1y_1 , whose origin lies at the center of the light spot and whose Oy_1 axis is directed along the rotor's radius; and Ox_0y_0 , related to system Ox_1y_1 by the relationships $y_0 = y_1 - r$ and $x_0 = x_1$ (cf. fig 2).

The equation for the boundary of the light spot in coordinate system Ox_0y_0 is

$$y_0 = \sqrt{R_0^2 - x_0^2} - \delta. \quad (4)$$

Areas S_1 and S_2 (cf. fig 2) equal

$$S_{1,2} = \int_{a_{1,2}}^{b_{1,2}} (\sqrt{R_0^2 - x_0^2} - \delta) dx, \quad (5)$$

where $a_{1,2} = \pm R_0 - (L \pm \delta_0)^2$; $b_{1,2} = -a_{1,2} + r\varphi$; $\delta = La$; $2\delta_0$ is the distance between photodiode stages; φ is the rotor's angle of rotation; L is the distance from the transverse plane of symmetry of the rotor to the surface of the photodiode; a is the angle of rotation of the rotor around axis Ox ; and $r\varphi$ varies from 0 to $2a_{1,2}$. Integrating (5), we get

$$S_{1,2} = \frac{1}{2} \left\{ (1 - a_{1,2} + r\varphi) \sqrt{R_0^2 - (a_{1,2} - r\varphi)^2} + R_0^2 \arcsin \frac{a_{1,2} - r\varphi}{R_0} + \right. \\ \left. + a_{1,2} \sqrt{R_0^2 - a_{1,2}^2} + R_0^2 \arcsin \frac{a_{1,2}}{R_0} \mp \delta r\varphi \right\}. \quad (6)$$

In computing area S_1 are used magnitudes a_1 and b_1 and the plus sign in the radicand for magnitude a_1 . Subscript "2" indicates area S_2 .

With small angles of rotation of the rotor around axis Ox it can be assumed that $a_1 \approx a_2$. Then, in keeping with (1) and (6) and upon the condition that $r\varphi = 2R_0$, the amplitude of pulses at the output of the amplifier equals

$$U_1 = 2K_1 K_2 / R_0 a, \quad (7)$$

where

$$K_2 = \frac{dI_d}{dR_0}$$

If the diameter of the light spot is commensurate with the width, h , of the photodiode stage, then according to calculations performed by (1), taking (6) into account, the shape of output pulses is close to sinusoidal. Expanding the train of sinusoidal pulses with a repetition rate and duration determined by (2) and (3) into a harmonic progression, we get for the angle indicator's output voltage

$$U_{out} = \frac{2K_g K_p L R_0}{\pi} \left\{ 1 + \sum_{k=1}^N \left[\frac{\sin \frac{\pi}{2} (2k-1)}{2k-1} + \frac{\sin \frac{\pi}{2} (2k+1)}{2k+1} \right] \cos k\omega t \right\}, \quad (8)$$

where

$$k = 1, 2, 3, \dots; \tau = \frac{t_p}{T_p}; \omega = \frac{2\pi}{T_p}.$$

It follows from (8) that the constant component of the angle indicator's output voltage does not depend on the rotational velocity of the gyroscope's rotor. The harmonic components increase with an increase in the duration of pulses, t_p , and are reduced with an increase in the pulse repetition rate, T_p . Periodic components are smoothed by means of an aperiodic element connected in the amplifier's output (cf. fig 3).

On account of technological inaccuracies it is not possible to drill holes equidistant from the axis of rotation. The geometrical position of hole center points can be represented in the form of a harmonic progression:

$$r = r_0 + \sum_{j=1}^{\infty} \Delta r_j \cos (j\Omega t + \psi_j), \quad (9)$$

where Δr_j is the amplitude of the j -th harmonic component of the deviation of hole centers from the specified radius, r_0 ; and ψ_j represents the initial phases of the j -th harmonic.

Taking (9) into account, it is possible to write (7) in the form:

$$U_m = 2K_g K_p R_0 \left[L\alpha + \sum_{j=1}^{\infty} \Delta r_j \cos (j\Omega t + \psi_j) \right]. \quad (10)$$

Thus, components which do not depend on angle α are present in the angle indicator's output signal. These components characterize the angle indicator's zero signal. With $j = 1$ noise is evidenced in the rotor's rotational frequency. For example, when the rotor's rotational velocity equals $n_r = 30,000$ r.p.m., the frequency of noise equals $f_1 = 500$ Hz. The frequency of the remaining components of the angle indicator's zero signal exceeds the frequency of the rotor's rotation.

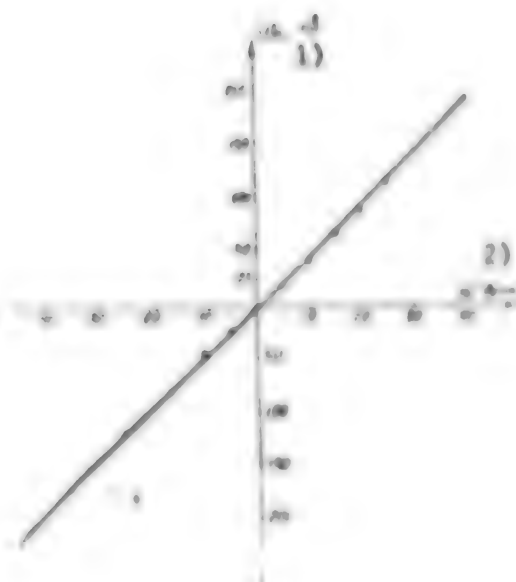


Figure 4.

Key:

1. U_{vykh} [output] - mV

2. Minutes of arc

In fig 4 is shown the static characteristic of a simulated model of an optical angle indicator having the following parameters: $R_0 = 0.5 \text{ mm}$; $r_0 = 20.25 \text{ mm}$; $l = 16 \text{ mm}$; and $c = 32$. In this indicator was used an FD-19KK multistage photodiode and the light flux was created by means of an OPZ-0,25 incandescent lamp with a current of $I = 0.2 \text{ A}$. The amplifier consists of a IUT402 operational amplifier with suspended elements: $R1 = R2 = 18 \text{ k}\Omega$, $R3 = R4 = 5.1 \text{ M}\Omega$, $R5 = 5.1 \text{ k}\Omega$, and $C1 = 0.1 \text{ }\mu\text{F}$. The rotational velocity of the rotor is $n_r = 30,000 \text{ r.p.m.}$ and $U = 450 \text{ mV}$. The number of holes in the rotor equals $i^r = 4$. According to fig 4 the transfer constant of the simulated model of the angle indicator equals $K_{\text{sim}} \sim 5 \text{ mV/minutes of angle}$. According to (8) the slope of the angle indicator's characteristic equals

$$K_{\text{sim}} = \frac{U R_0 K_0 L B_0}{\gamma} \quad (11)$$

Substituting in (11) the indicator's parameters, we get

$$\Delta U_{\text{al}} = \frac{2.780 \cdot 114 \cdot 10^{-3} \cdot 0.5 \cdot 16.450}{2.1 \cdot 10} = 5.85 \text{ mV/min. of angle.}$$

The zero signal (pulse amplitude) equals $U_0 \approx 5 \text{ mV}$. Here the inaccuracy in positioning hole centers relative to the mean radius equals $\Delta r = \pm 30 \mu$.

For the purpose of reducing the overall dimensions and improving the reliability of the angle indicator, the incandescent lamp can be replaced with a light-emitting diode. For example, it is advisable to use a ZL107B light-emitting diode to pair with an FD-19KK photodiode, for this LED has considerable power and matches the FD-19KK well with regard to spectral characteristics.

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CSO: 8144/0770

UDC 629.12.03-843.8-519

EXPERIENCE IN DEVELOPING THE REMOTE AUTOMATIC CONTROL SYSTEM FOR THE KAPITAN SMIRNOV GAS-TURBINE SHIP

Leningrad SUDOSTROYENIYE in Russian No 1, Jan 81 pp 24-26

ANDREZEN, V. A., VOYTEVSKIY, V. V., REMIZOV, B. D. and SHRAYER, A. I.

[Abstract] The authors discuss the problems solved in developing the Raskat system for automatic remote control of the engines and propulsion unit on the Kapitan Smirnov gas-turbine ship. Tests and the first working run of the ship showed that the Raskat system is effective, and provides convenient remote control from the bridge during docking, navigating through narrows and cruising. Figures 4, references 3 Russian.
[62-6610]

UDC 629.014.51

IMPROVING THE QUALITY AND RELIABILITY OF SHIP CONTROL BY USING A TURN INDICATOR

Leningrad SUDOSTROYENIYE in Russian No 12, Dec 80 pp 26-28

SHLEYER, G. E.

[Abstract] A turn indicator is proposed for use on the bridge of a river vessel to ensure a fixed turning radius so that maneuvering can be easily automated. The device informs the pilot of the future direction of motion of the ship based on the principle that the dynamics of motion of the vessel once the wheel is turned is predetermined, as is the development of the process of rudder control. The indicator is a sighting device that coincides with the diametral plane of the ship in the neutral position, and indicates the future course of the ship when the wheel is turned. Figures 5, references 5 Russian.
[61-6610]

CHOICE OF PARAMETERS OF A HIGH-FREQUENCY GYROSCOPIC TRANSFORMER CURRENT LEAD

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 23, No 12, Dec 80 pp 42-47 manuscript received 4 Jan 80

DELEKTORSKIY, B. A. and NIKANOROV, V. B., Moscow Power Engineering Institute

[Abstract] A high-frequency current lead contains a single-phase air-core transformer with movable secondary placed on the sensitive elements of a gyroscope, and a converter that changes frequency and number of phases to supply users of the sensing element such as a gyromotor. The turns of the air transformer core are wound in one or two layers on a cylindrical, disk or hemispherical coil form. The authors consider the major characteristics of the transformer: the harmful torque that it sets up with respect to the axes of the gyroscopic instrument, efficiency, and output voltage stability. It is shown that the harmful torque can be reduced by tuning the secondary circuit to resonance and increasing the frequency. The conditions that minimize the harmful torque also maximize the efficiency of the air-core transformer. For maximum transmitted powers of 6, 12, 24 and 48 W at a transmission frequency of 250 kHz, the average coil diameters should be 2, 3, 5 and 7 cm with a ratio of coil height to diameter equal to about 0.4. Figures 3.
[70-6613]

SYNTHESIS OF AN OBSERVING DEVICE TO EVALUATE THE CONDITION OF A TRIAXIAL GYROSTABILIZED PLATFORM

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 23, No 12, Dec 80 pp 59-63 manuscript received 10 Jun 80

LEPORSKIY, A. A., Leningrad

[Abstract] Observing devices can be used to evaluate angle coordinates and velocities that are inaccessible to instrumental measurement in gyroscope systems. The author considers the problem of designing an observing device for evaluating the angle coordinates and velocities of a gyro-stabilized platform with consideration of nonlinear cross connections. For the sake of simplicity it is assumed that the differential equations of motion of autonomous channels of the gyro-stabilized platform are linear, and perturbations in the platform are determined only by the inertial and velocity moments from rolling by the stabilization motors during motion of the base. It is assumed that these moments are measurable. The method of Lyapunov vector functions is used to design a nonlinear observing device that realizes an asymptotic estimate of the angular variables of the platform. References 4: 3 Russian, 1 Western.
[70-6610]

INVESTIGATION OF DYNAMIC PROCESSES OF THERMAL DRIFT OF FLOATING GYRO INSTRUMENTS

Leningrad IZVESTIYA VYSSHIKH UCHIBNYKH ZAVEDENIY: PRIBOROSTROYENIYE
in Russian Vol 23, No 12, Dec 80 pp 67-72 manuscript received 19 Jul 79

PANKRATOV, V. M. and DZHASHITOV, V. E., Saratov Polytechnical Institute

[Abstract] In the case of an inhomogeneous and unsteady temperature field of a floating gyroscopic device, convective flow arises in the working gap between the float and the body, leading to rotation of the float. Investigation of this kind of drift requires determination of the moment of convective forces that arise as the liquid moves in the cavity of the device. The authors find solutions for the differential equations of motion of an integrating gyroscope and a gyrotachometer with consideration of the way that the convective forces depend on time and the angular velocity of rotation of the float. Figures 2, references 5 Russian.
[70-6610]

UDC 531.383

CONCERNING SYSTEMATIC ERRORS OF A GYROPENDULUM ACCELEROMETER ON A VIBRATING BASE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17(27), No 1, Jan 81 pp 138-141
manuscript received 10 Oct 78

BEZVESIL'NAYA, Ye. N. and YEVGEN'YEV, V. S., Kiev Polytechnical Institute

[Abstract] An investigation is made of the constant component of error of a three-degree gyropendulum accelerometer carried on a moving object under conditions of random angular and translational oscillations of the base. The authors study the effect that the degree of irregularity of disturbing factors has on the indicated error of the instrument. The gyropendulum accelerometer is a heavy symmetric gyroscope in a three-degree Cardan suspension with vertical orientation of the axis of rotation of the outer frame. The device has two correction systems utilizing electric sensors of the angle and torque mounted on the axes of the gyroscope suspension and having proportional characteristics. The angle of turn of the outer frame in the steady state is proportional to the vertical component of apparent acceleration of the object, i. e. the difference between absolute linear acceleration and the acceleration due to gravity. Errors due to three-dimensional motion are corrected by signals from a pitch gyro and a gyrocompass. It is shown that when the ratio δ of the decay coefficient of the correlation function to the predominant frequency is equal to 0.3 or more, the degree of irregularity has little effect on precision for acceleration measurements within 10^{-5} m/s². For more precise measurements, a statistical approach must be used. For $\delta < 0.3$, the mathematical expectation of the error of the gyropendulum is nearly constant at about $3.4 \cdot 10^{-6}$ rad, so that the disturbing factor can be taken as harmonic, and a deterministic approach can be used for error analysis. Figure 1, references 3 Russian.
[66-6610]

UDC 536.24

RESULTANT TEMPERATURE FIELDS OF A SPACE WITH A SPHERICAL CAVITY

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 543-546
manuscript received 6 Dec 79 (abstract received 19 Feb 80)

LENYUK, M. P. and SEMENYUK, V. V.

[Abstract] The transient temperature fields of an isotropic homogeneous space with a spherical cavity are described by a scalar quantity, assuming the same relaxation time for thermal stresses in all directions. Solution of the corresponding equation of heat conduction in a medium with thermal stresses by the method of a Laplace integral transformation, for the appropriate initial and boundary conditions as well as the uniqueness condition with respect to the angular coordinates, yields the resultant temperature field as a sum of four terms: one volume-time integral, one time derivative of a volume integral, one volume integral, and one surface-time integral. The article has been deposited at the All-Union Institute of Scientific and Technical Information, No 1173-80. References 6.
[68-2415]

UDC 536.24.02

TEMPERATURE DISTRIBUTION IN A HOLLOW CYLINDER WITH PERIODIC VOLUME HEAT RELEASE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 543-545
manuscript received 6 Aug 79 (abstract received 11 Mar 80)

BELOUSOVA, L. Ye.

[Abstract] The problem of establishing a certain temperature distribution in a long hollow cylinder by means of heat sources in the volume and convective cooling of the surfaces is reduced to the equation of heat conduction with the appropriate initial condition and boundary conditions. The solution to this equation is obtained in the form of a series, assuming that the specific power of any one heat source located at radius r remains constant during periodically recurring intervals of time of the same duration and is zero during the intermissions also all of the same duration. The article has been deposited at the All-Union Institute of Scientific and Technical Information, No 1172-80. References 5.
[68-2415]

PROBLEM OF HEAT CONDUCTION INVOLVING AN INFINITELY LARGE PLATE WITH A
RECTANGULAR FOREIGN INCLUSION

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 542-543
manuscript received 5 Mar 79 (abstract received 25 Feb 80)

SEMERAK, P. V. and SEMERAK, M. M.

[Abstract] A thin infinitely large plate is considered with a rectangular foreign inclusion parallel to its edges. Convective heat transfer occurs from both surfaces of this plate to the ambient medium, while the temperature of the latter is zero at the lateral edges of the plate and t_0 at the lateral edges of the inclusion. The two-dimensional steady-state temperature field is calculated from the appropriate second-order differential equation of heat conduction, this equation being solved by means of a double integral transformation and a subsequent numerical analysis. The article has been deposited at the All-Union Institute of Scientific and Technical Information, No 1171-80. References 2.
[68-2415]

SOLUTION TO THE THERMAL PROBLEM OF EVAPORATION OF CONICAL SOLID BODIES IN A
HIGH-POWER RADIATION FLUX

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 532-537
manuscript received 4 Mar 80

SOLOV'YEV, I. A., All-Union Correspondence Institute of the Food Industry, Moscow

[Abstract] Evaporation of a conical solid body in a radiation flux is considered on the basis of the hyperbolic equation of heat conduction during phase transformation, with jumps in the values of the coefficients, i. e., in the thermophysical properties of the material. Evaporation is assumed to occur in vacuum, with the radiation flux entering at the vertex of a symmetric circular cone along the axis. It is first established that the hyperbolic equation implicitly includes the Stefan condition. Then formation of the new phase within a narrow region near the phase transition surface at the vertex is evaluated in terms of changes in the axial dimensions during the steady stage, i. e., when these changes occur at a constant rate. Numerical results are shown for an aluminum cone in a radiation flux of $10^{10} - 5 \cdot 10^{11}$ W/m², with the vertex angle varied from 4 to 60° and the temperature at the vertex correspondingly varied from 5538 to 5403 K. Figures 2; references 6: 5 Russian, 1 Western.
[68-2415]

TEMPERATURE FIELD OF THE ACTIVE CELL OF A SOLID-STATE LASER WITH A LIQUID-COOLING SYSTEM

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 520-526
manuscript received 26 Sep 79

DUL'NEV, G. N., GUR'YEV, Yu. L. and SUSLOV, S. G., Leningrad Institute of Precision Mechanics and Optics

[Abstract] A solid-state laser with a liquid-cooling system is considered and the temperature field of its active cell is calculated on the basis of the differential equations of transient convective heat transfer. The problem is treated as a coupled one, inasmuch as

$$N_{Br,z} = \frac{k_2}{k_1} \frac{r}{2} N_{Pr}^m N_{Re,z}^n, \quad n \geq 0.1 \text{ and}$$

$$K = N_{Br,z} [2N_{Pr}^m (\frac{r}{l})^{0.5}]^{-1} \geq 1 \quad (k_1 \text{ and } k_2 \text{ denoting the thermal conductivity of the}$$

solid and of the liquid respectively, r and z denoting the radial and the axial coordinates respectively, and l denoting the length of the active channel). Assuming constant properties of the liquid, this system of equations has been solved numerically, with the velocity of the cooling stream varied from 0.01 to 1.5 m/s, the thermal power in the cooling stream varied from 0 to 210 W and the thermal power in the active cell either 130 or 210 W. The results indicate how the temperature field evolves during the first six seconds, with the thickness of the thermal boundary layer increasing, also how it depends on the stream velocity and on the thermal power in the active cell. A velocity of the cooling stream within 0.8-1.0 m/s is deemed to be most effective for active cells with a thermal power up to 300 W, a stream with a higher velocity acting as a water screen and not having sufficient time to carry away the heat from the cooled surface, Figures 4; references 8 Russian.

[68-2415]

DEPENDENCE OF ULTRASONIC CAPILLARY RISE OF A LIQUID ON ITS PROPERTIES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 513-519
manuscript received 18 Jun 79

DEZHKUNOV, N. V. and PROKHORENKO, P. P., Physico-Technical Institute, BSSR Academy of Sciences, Minsk

[Abstract] An experimental study was made of the rise of a liquid (water) in a capillary tube due to the effect of ultrasonic waves, in addition to the rise due to capillary forces alone. The dependence of this ultrasonic effect on the wettability and the surface tension was determined using a plain glass tube and then either lining its inside wall with a film of 10% $(CH_3)_2SiCl_2$ solution in

benzene to reduce the wettability to zero or adding a surfactant (5% aqueous solution of acetic acid) to the water so as to vary the surface tension. The dependence of the ultrasonic effect on the gas concentration and the attendant cavitation level was measured by gas chromatography, the cavitation threshold found to become lower with increasing gas concentration. Its dependence on the vapor pressure was measured by raising the water temperature from 20 to 80°C, the effect of increasing vapor pressure found to be the same as that of increasing gas concentration, and its dependence on the viscosity of the liquid was measured by mixing the water with glycerin in various ratios. The results of these experiments indicate that the ultrasonic effect, which is associated with cavitation, does not depend on the wettability of the capillary wall surface and only slightly on the wettability of the capillary base surface. They also indicate that the collapse rather than the growth of bubbles plays the major role in the ultrasonic effect on capillary rise and it is the excess pressure above the meniscus, dependent on the viscosity of the liquid and on the gas concentration as well as on the vapor pressure and the surface tension, which determines the magnitude of the ultrasonic effect. Figures 4; references 11 Russian. [68-2415]

UDC 533.6.011+536.23

ANALYSIS OF HEAT LOSSES IN THE FORECHAMBER OF A GASDYNAMIC LASER DURING SIMULATION IN A SHOCK TUBE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 486-490 manuscript received 10 Oct 79

ACHASOV, O. V., BLAGA, Ya. and FOMIN, N. A., Institute of Heat and Mass Transfer imeni A. V. Lykov, BSSR Academy of Sciences, Minsk

[Abstract] A study was made to determine the heat losses in the forechamber of a gasdynamic laser simulated in a shock tube and to evaluate the effect of these losses on the system performance parameters. Measurements were made with a Mach-Zehnder interferometer including a compensation chamber where the gas density was held near its level behind a reflected shock wave. Calculations were based on theoretical relations for the heat losses through the end surface and through the lateral surface of the shock tube, as functions of time and of the temperature drop from the gas behind the front of a reflected shock wave and the respective surface of the shock tube. The results indicate a negligible effect of these heat losses on the thermodynamic state of the heated and compressed working gas. Figures 4; references 4: 3 Russian, 1 Western. [68-2415]

PROBLEM OF A PISTON IN A RELAXING GAS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 482-485
manuscript received 29 Aug 79

ZAKHAROV, N. S. and KOROBEYNIKOV, V. P., Institute of Mathematics
imeni V. A. Steklov, Moscow

[Abstract] The possibility of producing an inversion between $(04^{\circ}0-00^{\circ}1)$ and $(20^{\circ}0-00^{\circ}1)$ vibrational levels in a CO_2 molecule behind a shock wave is analyzed on the basis of the problem of a symmetric piston moving in an ideal and thermally nonconducting perfect gas, in this case a $\text{CO}_2+\text{N}_2+\text{He}$ mixture. Calculations are based on the model of two "modes" in CO_2 and N_2 molecules, the model of a harmonic oscillator for the lowest vibrational levels, and the equations of mass, momentum and energy conservation in the gas. Results are obtained for plane, cylindrical and spherical shock waves. Although the optimum conditions for shock-induced inversion have not been established here, it does not seem likely that the order of inversion can be further increased. Figures 4; references 7: 5 Russian, 2 Western.
[68-2415]

HEAT TRANSFER FROM A SPHERICAL SOURCE IN A RAREFIED GAS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 3, Sep 80 pp 428-434
manuscript received 7 Dec 79

MARGILEVSKIY, A. Ya., CHERNYAK, V. G. and SUETIN, P. Ye., Ural State University
imeni A. M. Gor'kiy

[Abstract] The heat transfer from a spherical source in a rarefied gaseous medium is calculated on the basis of diffusive scattering of gas molecules by the surface of the sphere. The state of the gas is described by a quasi-Maxwell distribution function, with the boundary condition corresponding to an arbitrary degree of accommodation of the energy of molecules at the surface of the sphere and linearized for the kinetic equation of this model. The latter equation is transformed first from a differential to an integral one and then to a system of integral moment equations in a convenient to solve matrix form. Asymptotic analytical solutions are obtained for the limiting cases of a continuum and of free molecules. For the intermediate range the thermal flux is evaluated by numerical methods. A special case is complete energy accommodation, corresponding to an energy accommodation coefficient $\alpha = 1$. Results of calculations by this method are in fair agreement with some other theoretical and scanty experimental data. Figures 2; references 5: 2 Russian, 3 Western.
[68-2415]

PLOTTING CURVES OF SCREW ACTION DURING REVERSING

Leningrad SUDOSTROYENTSE in Russian No 11, Nov 80 pp 11-12

MARTIROSOV, G. G.

[Abstract] Curves are plotted for the action of a variable-pitch screw during reverse maneuvering on a vessel of the Altay type by using the formula

$P_e = m \frac{dv}{dt} - R$ for calculating the thrust of the screw, where m is the mass of the

ship with consideration of the apparent mass of the water, v is the velocity of the ship, and R is the resistance of the water to motion of the ship. P_e is calculated by using the results of tests of forward motion to correct the drag curve $R = f(v)$, and then using the drag curve and the data on the reduction in velocity of the ship during reverse

$\frac{dv}{dt}$ to determine the thrust from the formula. The test

results agree completely with theoretical and model data. Figures 2.

[60-6610]

STEADY-STATE WAVES IN A CYLINDRICAL LAYER OF A STRATIFIED LIQUID

Moscow VESTNIK MOSEOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA
in Russian No 6, Nov-Dec 80 pp 62-66 manuscript received 11 Apr 78

GABOV, S. A. and KASTRO, R.

[Abstract] The article is a continuation of a series dealing with propagation of waves from a source of oscillations along a narrow equatorial region of the ocean that can be modeled by a cylindrical layer of liquid. Stratification of the ocean is accounted for by considering a two-layer liquid. It is assumed that a layer of ideal liquid covers a solid circular cylinder of infinite length. This layer in turn is made up of two layers of different density. The particles of liquid are attracted to the surface of the cylinder by the law of universal gravitation. In one sublayer is an infinitely long source of harmonic oscillations of a given frequency. The authors analyze wave motion on the free surface of the liquid and on the interface between sublayers, assuming that wave motions are infinitesimally small. Watson's lemma is used to derive simple asymptotic formulas that describe the process of wave propagation. The authors thank Professor S. V. Nesterov for constructive discussions. References 3 Russian.

[39-6610]

THE PROBLEM OF MOTION OF AN IDEALLY FLUID BODY IN THE FIELD OF GRAVITY OF n STATIONARY CENTERS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA
in Russian No 6, Nov-Dec 80 pp 99-103 manuscript received 23 Jan 80

DEMIN, V. G. and BARKIN, Yu. V.

[Abstract] The authors consider a set of n stationary centers with given masses in positions assigned by coordinates in an inertial reference frame. An analysis is made of the motion of an ideally fluid incompressible homogeneous body in which particles interact in accordance with Newton's law, and are simultaneously attracted by the stationary centers in accordance with the same law. It is shown that ellipsoidal figures of equilibrium exist for motion of an ellipsoidal body if the orbit of the center of mass is a circle. In the corresponding solution, the stationary centers are on an axis passing through the center of the orbit and normal to its plane. This result indicates that dynamic flattening of a central planet has an effect on the ellipsoidal figure of equilibrium of its satellite. In particular, the Roche limit for the angular velocity of revolution of the satellite decreases by an amount $-J_2(a/a_0)^2$, where J_2 is the coefficient of the second zonal harmonic of the force function, a_0 is the radius of the orbit, and a is the radius of the planet. The amount of this reduction is calculated for satellites of Mars, Jupiter and Saturn. References 5 Russian.
[39-6610]

HYPERSONIC FLOW AROUND CONICAL BODIES WITH INTENSE BLOWING

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 p 351
manuscript received 15 Oct 79

OVSYANNIKOV, M. P.

[Annotation of article deposited in the All-Union Institute of Scientific and Technical Information 6 Feb 80, registration No 1038-80 Dep]

[Abstract] The author proposes a method of determining the shape of the separating stream surface for infinite conical bodies of arbitrary cross section under conditions of intense blowing at $Re_x \rightarrow \infty$. Blowing is assumed to be normal to the wall of the body in a hypersonic flow. The surface of the cone is given in Fourier intercepts

$$\psi = \psi_0 + \sum \psi_n \cos n\phi + \sum \psi_m \sin m\phi.$$

Expressions are found for the increment in angle $\delta\theta$ due to blowing, and also for $\delta\theta'$ and $\delta\theta''$ in the case of circular and elliptical cones at a non-zero angle of attack. The separating stream surface is calculated for a circular cone at various angles of attack, and for an elliptical cone at zero angle of attack. References 3: 2 Russian, 1 Western.
[67-6610]

UDC 621.181.7:662.941.2

A NEW DEVICE FOR DISPERSING LIQUIDS IN GASES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 pp 354-355
manuscript received 7 Mar 79

VELICHKO, V. N.

[Annotation of article deposited in the All-Union Institute of Scientific and Technical Information 7 Jan 80, registration No 501-80 Dep]

[Abstract] The article describes a gas humidifier in which the liquid is broken up into droplets by a gas-blast atomizer. As a distinguishing feature of the device, it incorporates a nozzle that rotates in the gas. The nozzle is not axisymmetric: the outer generatrices copy the periphery of the disk to which the nozzle is fastened, and the inner surface of the nozzle is specially configured. The shape is described by a conformal mapping function. Experiments have shown that droplets at the outlet of the device are as small as 9-12 μ m. References 4: 3 Russian, 1 Western.
[67-6610]

UDC 536.33.001

CHARACTERISTIC OF EFFECTIVE EMISSION OF THE DIFFUSE SURFACE OF A CONE IRRADIATED BY A PARALLEL RADIANT FLUX

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 p 355
manuscript received 2 Apr 79

ROLESNIKOV, A. V.

[Annotation of article deposited in the All-Union Institute of Scientific and Technical Information 11 Feb 80, registration No 1032-80 Dep]

[Abstract] An analytical expression is found for the relative directional strength of effective radiation as a function of the directions of emitted radiation and incident flux, and the vertex angle of a thermally nonconductive cone with diffuse lateral surface exposed to a parallel radiant flux. The

resultant characteristic curve has applications in practical heat-exchange problems where graphic data are needed on directional dependence of radiation in two mutually perpendicular planes.
[67-6610]

UDC 629.78.03

RADIATION PROPERTIES OF A DIRECTIONALLY EMITTING PANEL SHIELDED BY A SCREEN

Misek INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 p 356
manuscript received 9 Jul 79

KOLESNIKOV, A. V.

[Annotation of article deposited in the All-Union Institute of Scientific and Technical Information 12 Feb 80, registration No 1039-80 Dep]

[Abstract] The author considers the radiative properties of a system made up of a fixed configuration of a directionally emitting panel beneath a cooled black shield. The panel has a flat surface of rectangular shape with long grooves of trapezoidal cross section. The bottom of the groove is a diffuse emitter, and the lateral surfaces of the grooves are ideal reflectors. The shield is a black surface at the absolute zero of temperature with its edge lying in the same plane as the edge of the panel. It is shown that the directional strength of radiation of this system is characterized by a Lambert law. This shows that the system can be used to simulate the field of thermal radiation of planets.
[67-6610]

UDC 532.645

CALCULATION OF STEADY-STATE HARMONIC OSCILLATIONS OF FLUID IN COMPLEX PIPELINES OF VARIABLE CROSS SECTION

Kazan' IZVESTIYA VYSSHIY UCHEBNYYH ZAVEDENIY: AVIATIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 14-19 manuscript received 13 Feb 78

BELIK, N. P. and CHIRVA, L. G.

[Abstract] The authors study the amplitudes of forced oscillations of pressure and flowrate of fluid (gas) in pneumohydraulic systems with continuously varying area of the flow channel. The analysis is based on a model of a complex branching pipeline made up of a number of single lines. It is assumed that the fluid flowrate varies exponentially in the initial cross section, and the problem is reduced to integration of a system of partial differential equations with given boundary conditions, and given conditions at the joints and at the branching

points. The final formulas are given for the amplitudes of fluctuations in pressure and flowrate of gas in such a pipeline for the case of steady-state forced oscillations. A numerical example is given. Figure 1, references 4 Russian. [63-6610]

UDC 536.24

INVESTIGATION OF HEAT TRANSFER IN BARRAGE COOLING OF A RECESS IN A SUPERSONIC FLOW

Kazan' IZVESHAYA VYSSHIKH UCHEB'NYKH ZAVEDENIY: AVIATIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 24-28 manuscript received 25 Nov 79

GORTYSHOV, Yu. F., YAKUSHEV, R. A. and SHCHUKIN, V. K.

[Abstract] Generalizing relations are found for heat exchange in barrage cooling under conditions where a recess is in a supersonic gas flow. Experiments were done in an open wind tunnel with a two-dimensional recess 50 mm long and 20-60 mm deep at a distance of 100 mm from the nozzle tip. In a supersonic air flow, an eddy system is set up in such a recess. The most intense main vortex arises in the center of the recess in contact with the main supersonic flow on one side and with the bottom of the recess on the other side. Secondary eddies in the corners of the recess interact with the main vortex. The main vortex shifts downstream with a reduction in depth of the recess. Secondary air is blown in through a flat slit 1 mm high tangent to the bottom of the recess in a direction coinciding with the velocity vector of the main vortex at the bottom of the recess. A heat flux sensor is placed on the bottom of the recess to analyze heat transfer during barrage cooling. Control experiments were done on a flat plate with a turbulent boundary layer without secondary blow-in to check reliability of the experiments. Analysis and generalization of the experimental results gives an expression for the intensity of heat transfer beyond the limits of the initial section in barrage cooling of a recess:

$$Nu_x = 0.25m^{1.86} Re_{xR}^{(0.93m^{-0.22} Re_L^{-0.025})},$$

where $Nu_x = \frac{\alpha x}{\lambda_{aw}}$ is the Nusselt number calculated with respect to running

coordinate x and parameters calculated with respect to the adiabatic temperature of the wall, α is the localized heat-transfer coefficient, λ_{aw} is thermal conductivity,

$m = \frac{\rho_s u_s}{\rho_0 u_0}$ is the blow-in parameter, ρ_s, u_s are the density and velocity of the flow in the injection slit, ρ_0, u_0 are the analogous parameters of the main flow,

$Re_{xR} = \frac{\rho_{aw} u_{sR} x}{\mu_{aw}}$ is the Reynolds number calculated with respect to the velocity of the injected jet, the running coordinate and the parameters determined with respect to adiabatic wall temperature,

$Re_L = \frac{\rho_0 u_0 L}{\mu_0}$ is the Reynolds

number calculated with respect to the parameters of the main flow and the length l of the recess, and μ_0 is the dynamic viscosity of the main flow. Figures 4, references 8: 7 Russian, 1 Western.
[63-6610]

UDC 621.438-621.532-181.4

CALCULATION OF THE EFFECTIVE ANGLE OF EXIT OF THE FLOW FROM THE RUNNER OF A CENTRIPETAL MICROTURBINE

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 29-36 manuscript received 8 May 80

GRACHEVA, S. M., TIKHONOV, A. N. and TIKHONOV, N. T.

[Abstract] Because of a lack of data on flow deflection behind the runner of a centripetal microturbine, the angle of inclination of the exit edges of the vanes on the runner is taken as the angle of exit of the flow in microturbine design. However, this assumption may be unrealistic because the configuration of the channel between vanes and the active eddy behind the runner may either increase or decrease the angle of exit of the flow as compared with the inclination of the vane edges. To economize on the labor and expense of microturbine design, the authors derive formulas for calculating the angle of exit flow based on analysis of the discharge of a gas jet from the intervane channel of a centripetal microturbine runner with consideration of all external forces acting on the jet in the two-dimensional approximation. Comparison with experimental data shows satisfactory agreement. Figures 2, references 3 Russian.
[63-6610]

UDC 532.526.4

LAW OF DRAG FOR TURBULENT FLOW IN ROTATING TURBOMACHINE CHANNELS

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 55-59 manuscript received 5 Jul 78

KORSHIN, I. N.

[Abstract] In the rotating channels of turbomachinery the flow, including in the boundary layer, is influenced by mass forces caused by rotation and curvature of the walls. The nature of the flow on the pressure and suction sides of the channel (vanes) is determined by the direction and gradient of the mass forces. In this paper, expressions are derived on the basis of the Monin-Obukhov scale for the boundary layer that define the distribution of the drag coefficients for turbulent flow in a rotating channel. It is shown that the drag laws differ for the

pressure and suction sides of a rotating channel and a stationary flat plate. Figures 3, references 7: 6 Russian, 1 Western. [63-6610]

UDC 534.142

EXPERIMENTAL STUDY OF EXCITATION OF ACOUSTIC VIBRATIONS IN A MULTICHANNEL BURNER SYSTEM

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 64-68 manuscript received 18 Apr 79

LARIONOV, V. M.

[Abstract] An examination of experimental data in the literature on self-excitation of longitudinal acoustic vibrations in a model of a rocket combustion chamber with multichannel burner shows that there has been no investigation of the conditions of excitation of vibrations for short mixing chamber lengths, and the mechanism of a stepwise change in frequency of vibrations with a change in mixing chamber length has not been explained. In this paper, experiments are done to study these problems as related to the rate of discharge of the mixture from the burner, the excess oxidant ratio, the diameter of the burner channels and the length of the mixing chamber. A theoretical criterion for excitation of vibrations is derived that correctly describes the conditions of excitation of acoustic oscillations in a multiple-burner system, and can be used for engineering calculations. By appropriate choice of mixing chamber length and burner channel radius, vibrations can be minimized for optimum proportions of fuel components (excess oxidant ratio close to 1.0) for a given range of fuel mixture consumption. Figures 3, references 3 Russian. [63-6610]

UDC 534.46

VIBRATION BURNING OF A GAS SUSPENSION OF LIQUID FUEL IGNITED BY FLAME JETS

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 118-120

TOKAREV, V. V.

[Abstract] An investigation is made of the conditions of onset of vibration burning in a gas suspension of liquid fuel ignited by flame jets, and of the influence that flame-stabilizing parameters have on this effect. Experiments were done on a model of a chamber in the form of a channel 2.5 m long of rectangular cross section with dimensions of 0.28 x 0.21 m. A grating was placed at the inlet to produce the critical pressure differential. The flame was

stabilized by flat flame jets emanating from nozzles of a self-contained burner, a small flat combustion chamber 0.075 m high and 0.18 m long. The outlet part of the chamber tapered off into flat nozzles. The experiments were done at air temperatures of 300 and 500 K at atmospheric pressure. The electrical conductivity of the flame was measured by a single-contact probe. The nature of the conductivity (thermionic electrons from hot carbon particles) showed the behavior of temperature in the flame stabilization region. Turbulizers were used to enhance mixing of the fuel jets with the igniting flame. Pressure pulsations were measured by sensors placed 2 cm away from the burner nozzle. It was found that vibration burning in a gas suspension of liquid fuel arises under conditions that lead to a reduction in the amount of heat entering the mixture from the flame jets, which brings about periodic interruption of the flame stabilization. Figures 2, references 3 Russian.

[63-6610]

UDC 621.438.536.244

RESULTS OF PROCESSING EXPERIMENTAL DATA ON HEAT TRANSFER IN HOLES TYPICAL OF TURBINE VANE PERFORATIONS BY THE METHOD OF LOCALIZED MODELING

Kazan' IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATIONNAYA TEKHNIKA
in Russian No 3, Jul-Sep 80 pp 120-122 manuscript received 10 Oct 78

TRUSHIN, V. A.

[Abstract] The paper gives the results of a study of heat transfer in the holes in perforated plates with geometric characteristics corresponding to turbine vane perforations. The plates were placed in the end of a transparent tube, and the main flow was injected from the other end of the tube. Secondary heated gas was periodically injected through side nozzles. Effluent flow was simulated by placing a cone base down over the plate with a gap that could be controlled. Standard instrumentation was used to record flow parameters, and thermocouples were used in combination with an oscilloscope to determine temperature fluctuations in the plate. Typical experimental results are given. Figures 2, references 2 Russian.

[63-6610]

PENETRATION OF CYLINDRICAL SOLIDS INTO A COMPRESSIBLE FLUID

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17(27), No 1, Jan 81 pp 26-33
manuscript received 28 Dec 79

KUBENKO, V. D., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A solution is found for the problem of penetration of an infinitely long rigid cylinder into a compressible fluid. It is assumed that penetration is by the lateral surface, and that the axis of the cylinder is parallel to the surface of the liquid, giving a two-dimensional problem. The analysis is based on an approach in which the linear coordinates along the surface of the impacting solid are identified with the coordinates along the surface of the liquid. Infinite systems of Volterra equations of the second kind are found for the components of the strain rate and pressure on the surface of the liquid. A formula is found for the polar angle of the contact (wetted) surface of the cylinder, which enables solution of the problem for a cylindrical solid with cross section defined in polar coordinates. The approach can be generalized to account for the rise of the free surface of the liquid over the surface of the cylindrical solid. Figures 3, references 10 Russian.
[66-6610]

INFLUENCE OF LONGITUDINAL COMPRESSION ON UNSTEADY OSCILLATIONS OF AN ELASTIC PLATE FLOATING ON A LIQUID SURFACE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17(27), No 1, Jan 81 pp 93-98
manuscript received 21 Aug 78

BUEATOV, A. Ye., Marine Hydrophysics Institute, UkSSR Academy of Sciences, Sevastopol'

[Abstract] An analysis is made of the effect that longitudinal compression has on the development of oscillations of a thin elastic beam plate due to time-periodic normal stresses. It is assumed that the plate floats on the surface of an ideal incompressible liquid of given depth. The plate and liquid are infinite in the horizontal directions. The periodic stresses applied to the plate at time zero are assumed to vary exponentially. At the initial instant, the plate and the liquid are in an undisturbed state. Assuming that the motion of the liquid is potential and that the velocities of liquid particles and bending of the plate are small, a Laplace equation is derived for the velocity potential with consideration of longitudinal compressive stress with given initial and boundary conditions. The problem is solved by the complex Fourier transform method. Figures 3, references 7 Russian.
[66-6610]

SOME PROBLEMS OF PENETRATION OF SOLIDS INTO A PONDERABLE FLUID

Yerevan IZVESTIYA AKADEMII NAUK ARMJANSKOY SSR: MEKANIKA in Russian Vol 33, No 4, Jul-Aug 80 pp 38-51 manuscript received 25 Oct 79

AVAGYAN, S. G. and BAGDOYEV, A. G., Institute of Mechanics, ArSSR Academy of Sciences, Arti Vocational School of Industrial Technology

[Abstract] An analysis is made of the problem of penetration of a slender rigid cone into a ponderable fluid with a free surface and with an elastic cover. The force of gravity is taken into consideration. Expressions are found for the pressure distribution over the cone and the drag in quadrature form. Expansion with respect to a small parameter gives the pressure distribution and drag with accuracy to η^4 , where

$$\eta = \frac{gt}{v_0} \quad (v_0 \text{ is the velocity of penetration}). \quad \text{In the case of}$$

coverage by an elastic membrane, an approximate solution is found for small values of the parameters η ,

$$\lambda = \frac{\rho}{\rho_0 v_0 t} \quad \text{and} \quad \alpha = \frac{T}{\rho_0 v_0^3 t}, \quad \text{where } \rho \text{ is the density of the}$$

membrane, ρ_0 is the density of the fluid and T is the tension of the membrane. It is shown that accounting for η and λ increases drag, while accounting for α reduces drag. Figures 3, references 7 Russian.
[65-6610]

UDC 621.08.658.562

EFFECT OF AXIAL MISALIGNMENT OF BEARINGS ON THE VIBRATION OF TURBOMACHINES

Moscow IZVESTIYA VISSHNIK UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian
No 12, Dec 80 pp 86-87 manuscript received 11 Apr 80

PONOMAREV, N. A., graduate student.

[Abstract] An experimental study was made concerning the effect of axial misalignment of journal bearings on the vibration of turbomachines, such a misalignment found to result in low-frequency vibrations caused by changes in the dynamic characteristics of the "shaft - lubricating film - bearing" system. Measurements were made on a 6K1 turbocompressor running at a nominal speed of 21,500 rpm at the Kolonna plant, using a Bruhl-Kjer vibroacoustic instrument with four inductive displacement transducers mounted 90° apart on each bearing. The initial axial misalignment was set at 39 μ m, with the runner vibrating in the fundamental mode of synchronous precession. Increasing the misalignment by an additional 6 μ m resulted in a soft loss of stability with an average 10 dB increase of the vibration amplitude. Increasing the misalignment by another additional 6 μ m resulted in a noticeable further 30-40% of an SI-69 oscilloscope and its speed was measured within a 1.5% accuracy with an ICh-7 frequency meter. The readings indicate a complex relation between axial misalignment of bearings and runner vibration in a turbomachine. Figure 1.
[78-2415]

UDC 624.072.23:534.16

NATURAL TRANSVERSE OSCILLATIONS OF CONTINUOUS MULTISPAN BEAMS

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 11-17 manuscript received
20 Mar 78

DMITRIYEV, A. S., Leningrad Institute of Railway Transportation Engineers

[Abstract] Frequency equations are derived as well as analytical relations for the modes of oscillations of a six-span beam, and dynamic characteristics found by the described method are given for systems with four and five spans. The

symmetry of the system is used in solving the problem. It is shown that continuous beam systems have an infinite number of frequency groups separated by frequency numbers $i = 1, 2, 3, \dots, \infty$, each group containing as many frequencies as the beam has spans. Figures 3, references 7: 4 Russian, 3 Western.
[58-6610]

UDC 621.874

FORCED TRANSVERSE STEADY-STATE OSCILLATIONS OF MULTIPLE-BEARING SHAFTING IN TURBOMACHINERY

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 23-28
[date received not available]

SHUL'ZHENKO, N. G. and ZHULAY, S. V.

[Abstract] The use of classical matrix methods for studying flexural oscillations of multiple-bearing shafting with a large number of sections requires special techniques for error correction. In this paper the authors consider the use of a finite element method incorporating ideas of initial parameters and dynamic stiffnesses for calculating oscillations of turbomachinery shafting without accumulation of considerable errors. The shafting is treated as a multiply supported rotating rod with a cross section that changes by steps. The unbalanced disks on the joints between sections are treated as lumped masses. The method accounts for the gyroscopic moments of the disks and the aerodynamic forces in the banding. Dissipation in the material is accounted for in Ye. S. Sorokin's form. Reaction of the oil layer, bearings, support base and aerodynamic flow is given in terms of the horizontal and vertical displacements of the shaft, and complex stiffness coefficients that characterize elastic and damping properties. An algorithm and program are given that can be used to study forced steady-state vibrations of multiple-bearing shafting in two planes with a large number of sections. Accounting for the pliability of the support base may have an appreciable effect on the dynamic displacements of the shafting.
[Number of references not available].
[58-6610]

STABILITY OF IMPERFECT CYLINDRICAL SHELLS UNDER TWO-PARAMETER LOADING BEYOND THE ELASTIC LIMIT

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 38-40
manuscript received 18 Sep 78

BATEVSKAYA, G. D., Institute of Problems of Machine Building, UkSSR Academy of Sciences

[Abstract] The author considers the influence of initial imperfections of thin-walled structures on stability beyond the elastic limit in the case of axisymmetric buckling. The analysis applies to stability in the large for flexible elastic-plastic cylindrical shells of finite length subjected to an axial force and internal pressure. The calculations are based on the theory of plastic flow with isotropic hardening. The problem is solved by the Ritz method in high approximations in combination with a step-by-step process. It is assumed that displacements are negligible compared with a characteristic dimension of the shell. The square of the angle of turn is taken as commensurate with the deformations, which are assumed to be small in comparison with unity. It is shown that even slight waviness of initial bending considerably narrows the stability region of flexible cylindrical elastic-plastic shells. Figures 2, references 9 Russian.
[58-6610]

UDC 539.3

SOLUTION OF PROBLEMS OF ELASTIC TWISTING OF BODIES WITH MULTILAYERED CROSS SECTIONS OF COMPLEX SHAPE

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 43-49 [date received not available]

DOLGOVA, I. M. and MEL'NIKOV, Yu. A.

[Abstract] Methods of integral representation of unknown quantities have been successfully used in solving boundary value problems of the theory of shells, elasticity and steady-state heat conduction. These methods are especially effective in application to bodies of complex shape. In this article the authors apply these techniques to media with physical inhomogeneity. In particular, an analysis is made of twisting of elastic bodies with composite cross sections of complex shape. The body is modeled by a stack of rectangular layers with an opening of arbitrary shape. It is shown that the proposed method is effective for solving problems of twisting of elastic prismatic solids with composite multiply connected cross sections of complex shape. Figures 2. [Number of references not available].
[58-6610]

OPTIMUM ELIMINATION OF VIBRATIONS IN PLATES

Kiev PROBLEMY MASHINOSTROYENIYA in Russian No 10, 1980 pp 53-60
manuscript received 14 Nov 77

KARNOVSKIY, I. A. and LANDA, M. Sh., Leningrad Engineering Construction Institute

[Abstract] Various methods are available for controlling vibration in a building: damping, isolation, shock absorbers. In this paper a numerical study is done on the control process as related to a number of factors: the kind of restraints, speed, attenuation and so on. It is assumed that the oscillations of a rectangular plate are described by a known equation, and that the initial conditions and loading law are given. A solution is found for minimizing the time of elimination of a known set of modes of vibration with known frequencies. A block diagram is given of a system for controlling vibrations of an object with distributed parameters. The proposed system is designed in accordance with the algorithm derived for optimum elimination of vibrations. The system can be modified to operate on an external action or on deviations (reactions).

Figures 6, references 4 Russian.

[58-6610]

UDC 531.01

OSCILLATIONS OF ONE-DIMENSIONAL SYSTEMS WITH A PERIODIC POTENTIAL

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA
in Russian No 6, Nov-Dec 80 pp 104-107 manuscript received 15 May 80

KOZLOV, V. V.

[Abstract] An analysis is made of nonlinear oscillations of one-dimensional mechanical systems described by equations of the form $\ddot{x} + \omega^2(1 + \epsilon f(t)) \sin x = 0$, where ϵ and ω are constants, and f is an analytical function of time with period 2π . Expressions are derived for the instability of vertical oscillations, and asymptotic surfaces are determined. The conditions of integrability of the system are defined. References 7: 6 Russian, 1 Western.

[39-6610]

AN ENERGY CRITERION OF ONSET OF SELF-OSCILLATIONS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA
in Russian No 5, Sep-Oct 80 pp 6.-66 manuscript received 16 Feb 79

CHERNYSLENKO, S. I.

[Abstract] The author considers systems of the form

$$\begin{aligned}\frac{d^2x}{dt^2} &= f + g(t, x, \dot{x}), \\ \frac{df}{dt} &= A(f, x) + B(f, x) \frac{dx}{dt}\end{aligned}$$

that are encountered in the theory of oscillations of ground-effect machines and in certain other applied problems. Let $f(t)$ and $x(t)$ be periodic solutions of system (1), (2). Multiplying (1) by dx/dt and integrating over the period, we get the energy condition imposed on $f(t)$ and $x(t)$:

$$\oint f \frac{dx}{dt} dt + \oint g \frac{dx}{dt} dt = 0.$$

Usually g is a dissipative force, so that the second term in this condition is non-positive, and hence

$$\oint f \frac{dx}{dt} dt \geq 0.$$

Then $f(t), x(t)$ on the f - x plane describes a contour whose area taken on the positive side going counterclockwise and with a minus sign in the other direction is equal to contour integral (3). The author considers the problem of the direction of travel around the contour, and hence the sign of integral (3). The following theorem is proved: if contour $f(t), x(t)$ lies in closed region G contained in open region \mathbb{R} , and if A and B are continuous bounded functions in \mathbb{R} , and if $\partial A/\partial f$ and $\partial A/\partial x$ exist along the curve $A(f, x) = 0$ and $\frac{\partial A}{\partial f} B + \frac{\partial A}{\partial x}$ does not change

sign or vanish, and if $f(t)$ and $x(t)$ satisfy equation (2), and if the set of points in which $A(f, x) = 0$ is connected then

$$\text{sign} \oint f dx = - \text{sign} \left(\frac{\partial A}{\partial f} B + \frac{\partial A}{\partial x} \right).$$

The author thanks Professor N. A. Slezkin for interest in this work and assistance in preparing it for publication. Figure 1, references 4 Russian.
[47-6610]

INVESTIGATION OF THE DYNAMICS OF A MULTILAYERED INHOMOGENEOUS HOLLOW BALL

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 1: MATEMATIKA, MEKhanIKA
in Russian No 1, Jan-Feb 81 pp 82-86 manuscript received 5 Jun 80

MOLODTSOV, I. N.

[Abstract] The author considers propagation of small radial perturbations in an N-layered thick-walled hollow sphere. It is assumed that motion is started from a state of rest by loads applied to the outer or inner surface. A system of differential-difference equations in dimensionless variables is derived for the motion of the sphere in terms of boundary displacements and stresses. References 3 Russian.
[44-6610]

UDC 539.3

CONCERNING THE INFLUENCE OF WEAK ANISOTROPY ON THE NATURE OF PROPAGATION OF CYLINDRICAL AND SPHERICAL SHOCK WAVES

Kiev PRIKLADNAYA MEKhanIKA in Russian Vol 17(27), No 1, Jan 81 pp 34-37
manuscript received 13 Sep 78

ROSSIKHIN, Yu. A., Bryansk Pedagogical Institute

[Abstract] An analysis is made of the propagation of shock waves that arise as a result of sudden application of loads to the boundaries of cylindrical or spherical cavities situated in an infinite weakly anisotropic elastic material of cubic symmetry. Expressions are found for the components of the vectors of intensities, and solutions are given for the cylindrical and spherical cases. Figures 2, references 3 Russian.
[66-6610]

UDC 539.3

INFLUENCE OF CUTOUTS ON THE NATURAL FREQUENCIES OF OSCILLATIONS OF CIRCULAR PLATES

Kiev PRIKLADNAYA MEKhanIKA in Russian Vol 17(27), No 1, Jan 81 pp 71-76
manuscript received 18 May 78

BELYAKOVA, S. G. and PREOBRAZHENSKIY, I. N., Moscow Aviation Institute

[Abstract] Equations are derived for determining the natural frequencies of oscillations of circular plates with cutouts. The solution is found in closed

form for the linear formulation, using an approximate method based on impulsive functions proposed previously by Preobrazhenskiy for solving the problem of stability of a rectangular plate with one or more cutouts of circular or rectangular shape. The essence of the technique is that the plate with cutouts is replaced with a "continuous" model made of a material with variable parameters of stiffness and mass that have discontinuities of homogeneity. The stiffness and mass appearing in the equation of oscillations are written in variable functions of the polar coordinates. Nomograms are given for calculating the natural oscillations of circular and annular plates weakened by circular cutouts of different radii. Figures 3, references 4 Russian.
[66-6610]

UDC 531.384

MOTION OF A THREE-DEGREE MECHANICAL SYSTEM WITH ROCKING

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17(27), No 1, Jan 81 pp 114-119
manuscript received 5 Nov 79

LOBAS, L. G., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Generalization and refinement are introduced into the formulation of the problem considered previously [see L. G. Lobas, "On Control and Programmed Motion of a Bicycle on a Plane", IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA, No 6, 1978, pp 22-28]. The generalization consists in eliminating the constraint of smallness of the coordinates and their derivatives, and the refinement involves consideration of galloping motion of the frame and steering fork due to inclined orientation of the steering column. Figures 2, references 2 Russian.
[66-6610]

UDC 539.3

PLANE DEFORMATION OF AN INFINITE CYLINDRICAL ORTHOTROPIC TUBE

Yerevan IZVESTIYA AKADEMII NAUK ARMJANSKOY SSR: MEKHANIKA in Russian Vol 33, No 4, Jul-Aug 80 pp 77-80 manuscript received 14 Nov 79

DOROGININ, V. V., Moscow State University imeni M. V. Lomonosov

[Abstract] An examination is made of the equilibrium of an elastic homogeneous cylindrically orthotropic tube loaded by predetermined surface forces. It is assumed that the axis of anisotropy coincides with the geometric axis of the cylinder. Mass forces are disregarded, and surface loading is taken as symmetric relative to some plane that passes through the axis of the tube. Fourier series are found for the resultant stresses. An example is given of stress analysis of a loaded ring. The author thanks Professor V. Ye. Pehedra for formulating the problem and for continued interest in the work. Reference 1 Russian.
[65-6610]

TESTING AND MATERIALS

UDC 621.787.4:621.921.34.669.2

EXPERIMENTAL EVALUATION OF METHODS OF IMPROVING THE PROPERTIES OF TITANIUM ALLOYS BEFORE DIAMOND SMOOTHING

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 1, Jan 81 pp 41-43

YERSHOV, A. A., candidate of technical sciences, MIKHAYLOV, A. A., doctor of technical sciences, and NIKIFOROV, A. V., candidate of technical sciences

[Abstract] A variety of methods have been proposed for pretreating titanium and its alloys to achieve the required antifriction and antiseizing properties for subsequent diamond smoothing. Among the suggested techniques for this purpose are the method of gas saturation of the surface, application of electrochemical coatings, and chemical heat treatment by passivation in the melts of alkali metal salts. The authors report on experiments done to evaluate such methods. The overall coefficient of friction was studied on a facility with a lever system for producing a load P_y and strain gages for measuring the force P_z . It was found that the optimum treatment is passivation in a melt of alkali metal salts, which reduces the overall coefficient of friction by a factor of 1.5-2 and reduces the adhesion component of friction by a factor of 3-4. There is also a proportional reduction in the coefficient of relative adhesion. Figure 1, references 6 Russian.

[59-6610]

UDC 621.923:669.295]:621.921.34

HIGHLY EFFECTIVE DIAMOND WHEEL GRINDING OF TITANIUM ALLOYS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 1, Jan 81 pp 45-47

MISHNAYEVSKIY, L. L., candidate of technical sciences, and GALKOV, A. V., engineer

[Abstract] A comparison is made between synthetic diamond and borazon grinding wheels for machining titanium alloys. It is found that wear of diamond wheels is only one-third of the level for borazon wheels. Studies with metallized synthetic diamond wheels showed that this type of abrasive has good cutting

properties arise when the diamond grains are clogged with metal from the workpiece. Observations and measurements show that grain wear is slow and uniform without coarse splitting. Maximum observed linear wear was 10 $\mu\text{m/hr}$. Studies of the quality of the finished surface layer of titanium alloys ground with diamond wheels and the results of fatigue tests showed that grinding with synthetic diamond wheels produces a high-quality surface. These wheels are currently being used for machining titanium alloys in nine machine-building enterprises in the Soviet Union. The introduction of this technology has saved more than 1.5 million rubles annually. References 3 Russian.
[57-6610]

UDC 621.787.4:621.921.34

IMPROVING THE DURABILITY OF COMPONENTS WITH STRESS CONCENTRATORS BY DIAMOND SMOOTHING

Ukraine VESTNIK MASHINOSTROYENIYA in Russian No 1, Jan 81 pp 47-49

YEROLIMOV, V. I., candidate of technical sciences, and NITRYAYEV, K. F., candidate of technical sciences

[Abstract] Studies are done to determine the sensitivity of diamond-smoothed components to stress concentrators such as slashes, notches and grooves with operation at normal and elevated temperatures. Fatigue were done on specimens of 1Kh12S2V8F high-chrome heat-resistant steel and Kh17QMVTuB high-temperature deformable nickel-base alloy. Some of the specimens were polished by a graphite wheel to a surface roughness parameter of $R_a = 0.16-0.31 \mu\text{m}$ and nearly zero residual stresses in the surface layer. The other specimens were ground on conventional corundum wheels and treated by diamond smoothing to a surface roughness parameter $R_a = 0.08-0.2 \mu\text{m}$. Residual compressive stresses remain high after heating to 400°C and holding for 11 hours. The results of the tests show that diamond smoothing reduces the sensitivity of the material to stress concentration. The increased durability of specimens that are diamond smoothed and notched as compared with those that are polished with a graphite wheel and notched is attributed to the considerable residual compressive stresses on the bottom of the notches that weaken the action of the working tensile stresses. The use of diamond smoothing to strengthen surfaces adjacent to stress concentrators improved the fatigue strength of components by 15-100%, depending on the type of stress concentrator. Figures 4, references 3 Russian.
[59-6610]

OPTIMIZING MULTILAYERED THERMAL INSULATION

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 39, No 2, Aug 80 pp 286-291
manuscript received 2 Jan 81

MIKHAYLOV, V. V.

[Abstract] A standard method of protecting heat-stressed components from the action of high temperatures is to cover the surface with layers of thermal insulation. An analysis is made of the problem of optimizing such insulation with respect to mass. This is reduced to the problem of finding the thicknesses of n layers of different materials such that the mass of the multilayered insulation is a minimum with consideration of temperature constraints on the interfaces, assuming that thermal contact between layers is ideal. An iteration scheme is proposed for solving the problem, using a penalty function with gradient calculated on the basis of solving the conjugate boundary value problem. Solution of this problem for temperature variations is used to estimate the change in the penalty function. References 5 Russian.
[67-6610]

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